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OBSERVATIONS OF NOCTURNAL RADIATION AT FAIRBANKS, ALASKA, AND FARGO, N. DAK.

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OBSERVATIONS OF NOCTURNAL RADIATION AT FAIRBANKS, ALASKA, AND FARGO, N. DAK.

By H. Wexler

[U. S. Weather Bureau, Washington, D. C.]

During the winters of 1936–37 and 1937–38, aerological observations and measurements of outgoing radiation were made at Fairbanks, Alaska, (65°51′ N., 147°52′ W.), and Fargo, N. Dak. (46°54′ N., 96°48′ W.), as part of an investigation of the formation and structure of polar continental air. The aerological observations have been published by Byers (1940); in the present report, only the radiation measurements are considered, although the discussion involves use of the aerological data.

DESCRIPTION OF INSTRUMENTS

At both stations the radiation instrument used was the Abbot-Aldrich melikeron (Aldrich 1922), which is used as a compensation instrument in measuring nocturnal radiation. Two junctions of a thermocouple are connected to a galvanometer; and when the "honeycomb" cell, to which one of the junctions is attached, is shielded from radiational cooling by a shutter, the galvanometer will show a certain deflection. When the shutter is lifted, the "honeycomb" will cool, thus changing the galvanometer reading; however, by means of dry cells the "honeycomb" is heated by a current which compensates for the cooling so that the galvanometer reading remains constant. The current is measured by a milliammeter; and $Q = KI^2$, where Q is the effective outgoing radiation in gm. cal./ $cm.^2$/min., I is the current in amperes, and K the constant of the melikeron. The constant of the melikeron is determined either by computation, from the dimensions and properties of the instrument, or by direct comparison with a standard instrument. The constant for the melikeron used at Fairbanks was 3.49, and for the instrument used at Fargo was 3.90, as determined by the Smithsonian Institution during July 1936. In November 1938, the instruments were recalibrated by the Smithsonian Institution and the new constants found were 3.75 and 4.03, respectively, or increases of 7 percent and 3 percent, respectively. According to Aldrich, the change resulted from a gradual deterioration of the reflecting surface located at the bottom of the "honeycomb." The original calibration constants were used throughout in determining the outgoing radiation.

Portable mirror type galvanometers (D'Arsonval) with a sensitivity of 0.025 microamperes per mm. division, an internal resistance of 1,100 ohms, and an external critical damping resistance of 12,000 ohms, were used as zero instruments; and dry cells supplied current to the circuits; the current supplied to the "honeycomb" was measured by a Weston milliammeter.

Observations of wind direction and velocity were made, together with measurements of snow surface temperatures and temperature of the air in the immediate neighborhood of the melikeron. The snow surface temperatures were observed by placing an alcohol thermometer horizontally on the snow with the bulb barely covered with snow. The percentage and types of clouds, and the depth and character of the snow on the ground, as well as other meteorological phenomena, were also observed and recorded.

OBSERVATIONS AT FAIRBANKS, ALASKA

The observations at Fairbanks were begun during October 1936, and continued until March 1937, and were again resumed during the period from October 1937 to March 1938. During the first winter, the observations were made by W. B. Drawbaugh of the Weather Bureau, to whom great credit must be given for evaluating the twice daily airplane soundings as well as making the radiation measurements, often under very trying circumstances. Mr. Drawbaugh returned for the second winter and, together with L. A. Coffin, conducted a program of radiosondes, occasional airplane soundings for check purposes, and radiation measurements.

The first winter the melikeron was mounted on a pole 1.2 meters above the roof of the office, or 5 meters above the snow surface. During the second winter until January 1, 1938, it was mounted 3.8 meters above the ground, and thereafter 1.7 meters and well away from the building. Insulated wires connected the melikeron with the current–measuring instruments inside the building. Many of the measurments were made within a few hours of the time of the airplane soundings or radiosondes.

Light winds prevailed at Fairbanks during the winter and hence there was little trouble with the fluctuations in galvanometer deflection usually caused by high winds. However, considerable difficulty in securing readings was experienced because of local smoke and light fog, particularly at the lower temperatures during the winter. Lignite and wood are the usual fuels consumed at Fairbanks, and many times during the period of observations clouds of smoke drifted southward over the airport where the observatory was located. Light to dense fog very often formed at temperatures below −20° C. and, of course, reduced the amount of outgoing radiation. The formation of hoar frost on the instrument also caused difficulty in obtaining accurate readings. The melikeron was carefully examined before readings were taken, and if frost was present the melikeron was brought inside to dry out before readings were attempted, as was also done if any blowing snow got into the instrument. Readings were abandoned on a number of occasions due to frost forming before or during observations, as any form of moisture on the instrument resulted in a reduction of outgoing radiation values and a fluctuating zero galvanometer reading. Readings taken under frosting conditions were not tabulated.

OBSERVATIONS AT FARGO, N. DAK.

The observations at Fargo were begun during September 1936, and continued until March 1937. They were again resumed during the period from October 1937 to March 1938.

The melikeron was mounted above the southeast corner of the airport building, 7.5 meters above the ground. The horizon surrounding the instrument was perfectly clear except for a radio mast and a revolving beacon tower. Wires leading into the building connected the melikeron with the measuring instruments inside.

Most of the radiation measurements were made within a few hours of the time of the daily airplane soundings at Fargo, and many were made simultaneously with the soundings.

Considerable difficulty was experienced with fluctuating galvanometer readings due to prevalence of strong gusty

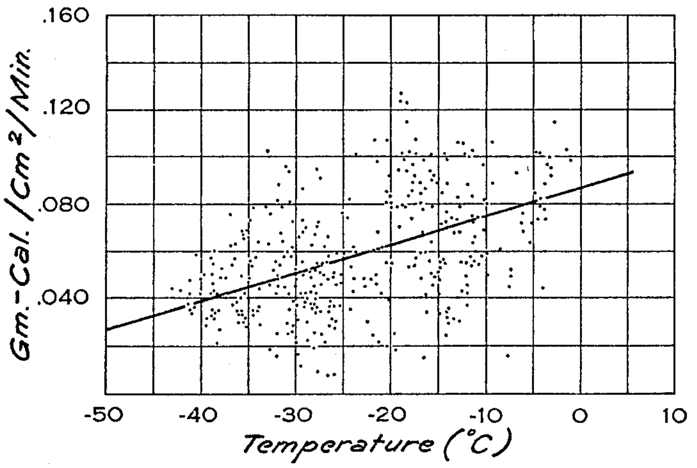

FIGURE 1.—Observed values of outgoing radiation during clear weather at Fairbanks, Alaska, 1936–38.

winds, as well as to blowing snow. The wandering of the galvanometer zero was caused by unequal heating or cooling by wind of the thermocouple junctions, one of which was well protected from exposure while the other was not. The galvanometer was particularly unsteady in southeast winds, which usually occurred when a warm front was nearby. This effect was probably caused by rapid temperature fluctuations brought about by mixing of the shallow cold layer of air with the much warmer air above. Some difficulty was encountered with frost forming on the melikeron surfaces, in which case no readings were attempted. When fluctuations occurred due to gusty winds, some improvement was made by insulating the lower portion of the melikeron with cotton batting, leaving the face of the instrument exposed.

OUTGOING RADIATION DURING CLEAR WEATHER

In figures 1 and 2, the individual values of outgoing radiation for clear weather are plotted against temperature (of the air near the melikeron) for Fairbanks and Fargo. The pronounced scattering agrees with that found by Mosby (1932) in his discussion of the *Maud* results, and is to be expected in view of the marked day-to-day variations of temperature and moisture content occurring aloft over the stations even when the surface conditions remain the same. If, on the other hand, the values of radiation coming from the atmosphere are found (by subtracting the outgoing radiation from the black body radiation at the temperature of the melikeron), and these values are plotted against the maximum temperature of the air aloft, then as seen in figure 5, the scattering is much less pronounced, indicating that the magnitude of the surface inversion influences greatly the value of the outgoing radiation. That the variations in moisture content are quite important is illustrated by the scattering in the latter figure.

In table 1 are shown the linear formulae found by the least squares method for Fairbanks and Fargo, as well as those for the following stations: Calm Bay, Franz-Joseph Ld. (Berezkin, 1937); *Maud* Expedition; Mount Nordenskiöld, Spitsbergen (Olsson, 1936); and Fort Smith, N. W. T. (unpublished data for this station were kindly furnished by J. Patterson, Controller of the Canadian Meteorological Service).

TABLE 1.—*Least squares formulae for outgoing radiation during clear weather (including cloudiness up to 2/10).*

Station	Date	Instrument	Number of observations	Temperature range, °C.	Formula derived
Fairbanks, Alaska (65°51′ N., 147°52′ W., 135 m.).	1936–38	Melikeron No. 5	358	−1 to −44	$Q=0.087+0.0012t$
Fargo, N. Dak. (46°54′ N., 96°48′ W., 274 m.).	1936–38	Melikeron No. 4	172	−5 to −35	$Q=0.076+0.0006\,t$.
Calm Bay, Franz-Joseph Land (80°19′ N., 52°48′ E.).	1933–35	Savinov pyrgeometer.	381	−1 to −38	$Q=0.140+0.0007\,t$.
Fairbanks, Alaska	1936–38	Melikeron No. 5	222	−20 to −40	$Q=0.105+0.0018\,t$.
Maud Expedition (Eastern portion of northern Siberian coast).	1922–25	Melikeron No. 1 (some of earlier observations were made by Ångström Pyrgeometer No. 56).	269	−20 to −40	$Q=0.105+0.0014\,t$.
Fort Smith, N. W. T. (60°0′ N., 111°53′ W., 210 m.).	1937	Melikeron No. 6	65	−12 to −45	$Q=0.062+0.0008\,t$.
Mount Nordenskiöld, Spitsbergen (78°11′ N., 15°26′ E., 1049 m.).	1932–33	Ångström Pyrgeometer No. 46.	192	near −20	$Q=0.147$.

The lines given by the formulae are plotted in figure 3, and show an increase in outgoing radiation with temperature. At higher temperatures Fairbanks has slightly higher values than Fargo, but this condition is reversed at temperatures below −18°. Both stations, however, have higher values than Fort Smith. For the −20° to −40° range the *Maud* and Fairbanks lines are almost parallel, although the former values are somewhat higher. Calm Bay and Mount Nordenskiöld, less than 1,300 km. apart, are in good agreement considering their difference

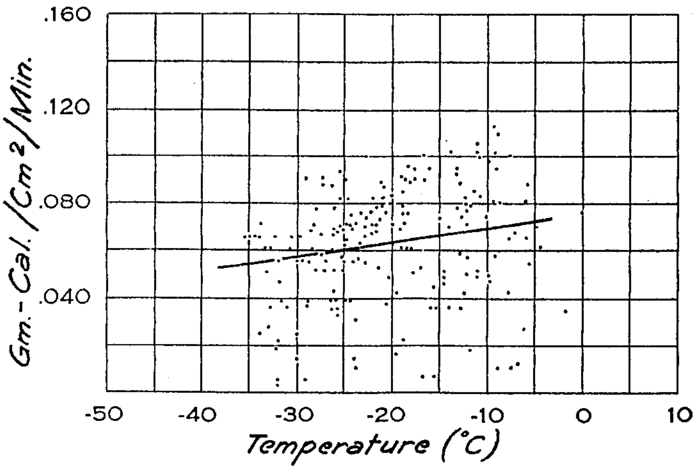

FIGURE 2.—Observed values of outgoing radiation during clear weather at Fargo, N. Dak., 1936–38.

in elevation and type of instrument used. The surprising difference is seen in comparing the values for Calm Bay and Mount Nordenskiöld with those of remaining stations; it cannot be explained by the use of different radiation instruments, since as Mosby points out (1932) the comparisons between the Ångström pyrgeometer and the melikeron showed that the latter reads only about 4 percent lower than the former. It seems as if the explanation must be sought in the different thermal structure of the atmosphere above the two groups of stations. If a smaller surface temperature inversion is found over Calm Bay and Mount Nordenskiöld than over the other stations, it would be associated with a higher value of outgoing radiation, since the outgoing radiation is the difference between the upward radiation from the ground and the downward radiation from the atmosphere, and

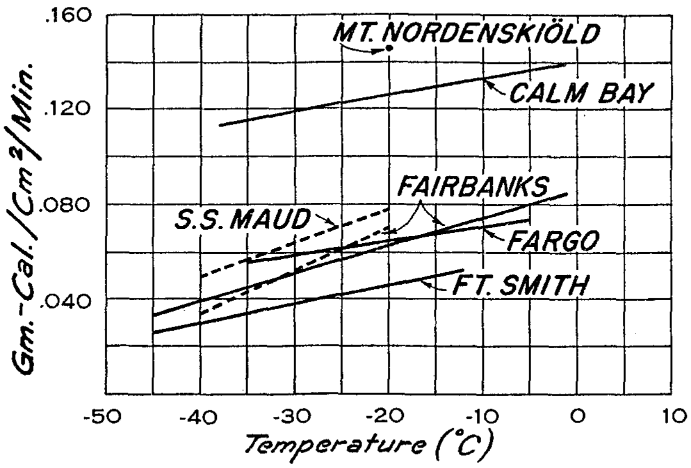

FIGURE 3.—Least square representations of observed outgoing radiation.

this difference diminishes as the magnitude of the surface inversion increases.

To test this hypothesis, in figure 4 the mean February temperature-height curves for the *Maud* (Sverdrup 1933), Franz-Joseph Land (Guterman 1938), Fairbanks (Byers 1940), and Fort Smith [1] observations have been plotted. Actually, of course, it is not permissible to assume that the mean temperature soundings are representative of days on which radiation measurements were made. These latter days, because they are chosen for lack of clouds, will be colder at the surface than cloudy days which have been included in the mean soundings. The *Maud* curve, based on kite data, shows a thin surface layer of relatively steep lapse rate (since soundings could be made only in time of moderate wind) and then a marked inversion above. The difference between the maximum temperature aloft and the surface temperature is 9.6°, and agrees quite well with the mean of such differences, 10.3°, found only from those soundings made close to the time of radiation measurements. The mean curve for Franz-Joseph Land shows only a slight increase in temperature from the surface to 1,000 meters and a normal lapse-rate above. However, it must be kept in mind that the radiation and aerological observations were not made at the same station on Franz-Joseph Land, nor were they made for the same period of time. The mean surface temperature at which the former measurements were made was −26.3°, about 10° lower than the mean surface temperature observed during the aerological soundings. Hence it cannot be definitely proved on the basis of the present data that the surface inversion at Calm Bay is smaller than that of the *Maud*, Fairbanks, or Fort Smith data. The Fairbanks mean sounding is nearly identical with that for Fort Smith above the surface layer. As for Mount Nordenskiöld, Olsson (1936) states that this station is above the surface inversion.

Interpreting the results, it seems that for air of recent maritime origin, such as that over Mount Nordenskiöld and Franz-Joseph Land, the outgoing radiation is large; and that when the air has achieved a quasi-radiative equilibrium with the surface, (i. e. when a large surface inversion is formed) the outgoing radiation becomes much less.

[1] These data are soon to be published by the Canadian Meteorological Service.

COMPARISON OF OBSERVED AND COMPUTED ATMOSPHERIC RADIATION DURING CLEAR WEATHER

In a previous paper by the author (Wexler 1936) an attempt was made to compute the radiation from a cloudless atmosphere by the simplified method introduced by Simpson (1928) and later used by Brunt (1929). Simpson was primarily interested in the absorption of the long-wave radiation by the stratosphere, which he assumed contained 0.3 mm. of precipitable water vapor and 0.06 gm. of CO_2 in a vertical column of 1 sq. cm. cross-sectional area. Using Hettner's determination of absorption by water vapor (in the form of steam) (1918) and Rubens-Aschkinass' CO_2 absorption (1898), Simpson was able to find the absorption spectrum of the stratosphere, which he showed coluld be divided into three spectral regions: (1) nearly complete absorption in the regions $5\frac{1}{2}$—7μ and for wave lengths greater than 14μ, called "opaque" bands; (2) semitransparency in the bands 4–$5\frac{1}{2}\mu$, 7–$8\frac{1}{2}\mu$, and 11–14μ; and (3) transparency in the region $8\frac{1}{2}$–11μ. Brunt later applied this same analysis to tropospheric radiation; he assumed that layers of air containing 0.3 mm. of precipitable water would absorb and transmit radiation according to Simpson's classification. However, in the troposphere such layers are very thin and do not contain 0.06 gm. CO_2, which Simpson assumed to be present in the stratosphere, and which was highly important because it decreased the lower limit of the complete absorption band from 20μ, the value when water vapor alone was present, to 14μ [2].

Hence, the application of Simpson's work to tropospheric radiation implies a large value of absorption and emission,

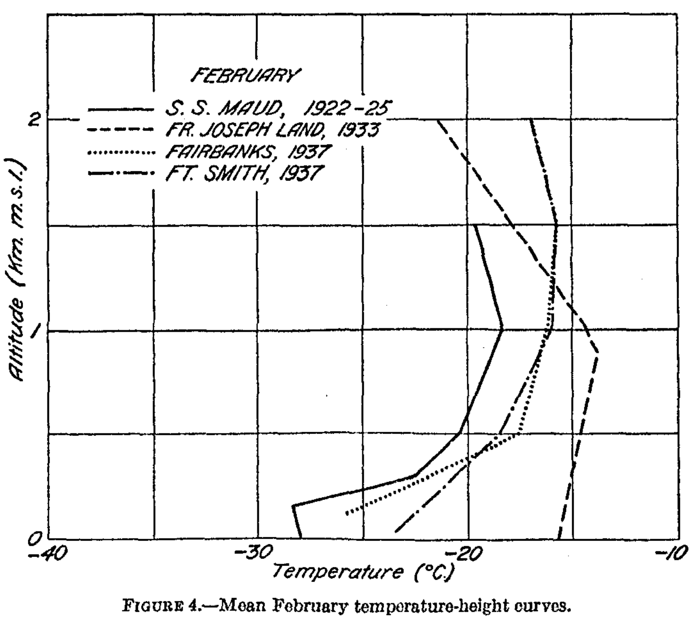

FIGURE 4.—Mean February temperature-height curves.

both because of use of absorption constants determined by steam instead of water vapor at atmospheric temperatures, and because of assuming an abnormal amount of CO_2 to be present in tropospheric air. Consequently

[2] Because of the diffuse nature of radiation the mean path of the radiation will include approximately twice the amount of absorbing gas; thus diffuse radiation passing through a layer, each of whose unit columns contains 0.15 mm. H_2O and 0.03 gm. CO_2 will be absorbed in approximately the same proportion as a parallel beam passing through a layer each of whose unit columns contains 0.30 mm. H_2O and 0.06 gm. CO_2.

another model was set up based on absorption coefficients determined by Weber and Randall (1932) using water vapor at room temperatures. These coefficients were so much lower than those of Hettner's, that in order to estimate the atmospheric absorption and emission in the manner used by Simpson, it was necessary to increase the thickness of the layers so that each contained 1 millimeter of precipitable water instead of 0.15 mm. If this were not done, the semitransparent bands would increase in width at the expense of the opaque bands and it would be impossible to estimate the amount of energy contained in them in the simple manner outlined by Simpson for the case of narrow semitransparent bands. Another very important consideration was the assumption of normal CO_2 content in layers; this decreased the absorption in the important band 14–17μ, so that this region became semitransparent instead of opaque. The new spectral limits of the 3 bands now become: (1) *Opaque* 5½–7 μ, $>$ 17μ; (2) *semitransparent* 4–5½μ, 7–8½μ, 13–7μ and (3) *transparent* 8½–13μ.

The two models, one showing large absorptivity and the other small absorptivity, were both used in the previous paper (Wexler 1936, fig 4) to determine the radiation coming from a moist atmosphere. In this diagram, the curves of which are reproduced here in figure 5, the abscissa represents the following temperatures, according to which of the 3 curves is referred to: *Curve* (*a*), temperature of the ground or snow surface, which is assumed to radiate as a black body; (*b*), the highest mean temperature of any layer of air containing 0.15 mm. precipitable water and high CO_2 content, and (*c*) the highest mean temperature of any layer of air containing 1 mm. of precipitable water and normal CO_2 content.

This diagram was used to find the magnitude of surface inversions formed over a snow surface in absence of sun and of wind movement. As was shown, the cooling proceeds in such a way as to create an isothermal layer above a large surface inversion, and the top of this isothermal layer represents the top of the true polar continental air. All evidence, such as the magnitudes of the inversions, rate of cooling, observed structure of polar continental air, analysis of Olsson's radiation measurements at Mount Nordenskiöld, etc., (Wexler 1936, 1937) seemed to favor *curve* (*c*) over *curve* (*b*) as representing the atmospheric radiation.

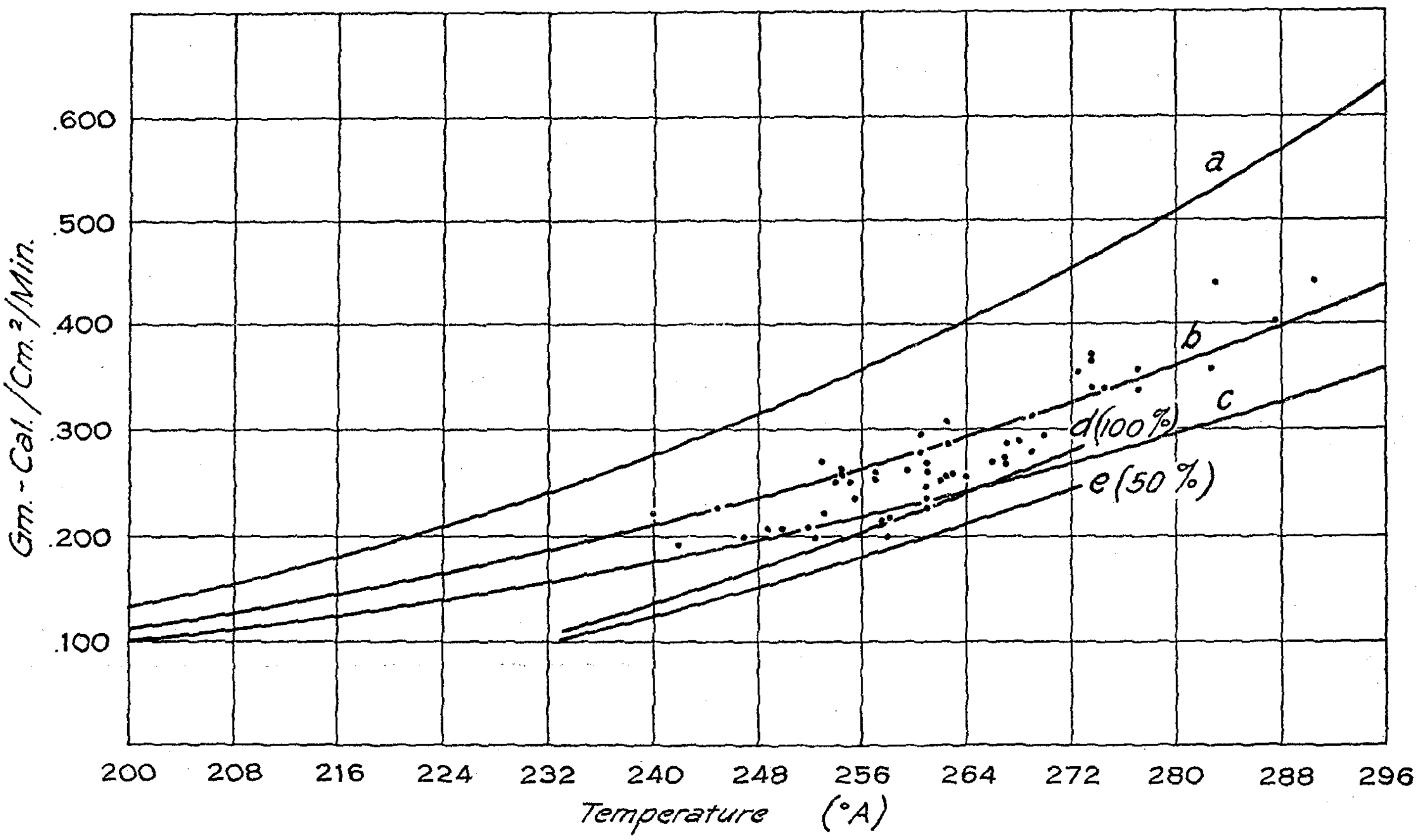

FIGURE 5.—Theoretical radiation compared with observed values.

Now the simultaneous aerological and radiation data at Fairbanks and Fargo afford a direct check of *curves* (*b*) and (*c*), in either of two ways: First, by plotting the observed values of atmospheric radiation against temperature of the isothermal layer when the latter can be determined from the aerological soundings; or, secondly, by plotting the values of atmospheric radiation against mean temperature of the surface layer of air containing 0.15 mm. of precipitable H_2O in one diagram to check *curve* (*b*), and plotting the same values of radiation against mean temperature of the surface layer of air containing 1 mm. of precipitable H_2O in another diagram to check (*c*). Both these methods have been followed, and the results are shown in figures 5, 6, and 7;[3] however, for reasons to be mentioned below, neither method is quite satisfactory.

The ideal structure of polar continental air, that is, a marked surface inversion in a very thin layer, overlain by an isothermal layer, above which is found the normal lapse-rate, is not observed in all soundings made in this type of air. Various effects such as the wind-stirring of

[3] It can easily be shown that for errors of +7 percent and +3 percent, caused by changes in the calibration constants at Fairbanks and Fargo, respectively, the percent error in atmospheric radiation will in general be less than −3.5 percent and −1.8 percent, respectively.

surface layers, different histories of various layers of air, possible radiative cooling from the lower layers directly to space, etc., obscure the ideal pattern and render difficult at times the identification of the isothermal layer. The values plotted in figure 5 are taken only from soundings where the isothermal layer was easily identified. From the soundings made during the winters of 1936–38 at Fairbanks and Fargo, only 54 such cases were observed during which radiation measurements were also available.

The results are in agreement with those found from the first winter's observations at Fairbanks and Fargo (Wexler 1937; the 48 points referred to in this paper were considerably reduced in number by demanding closer adherence of the soundings used to the ideal temperature distribution). At temperatures between −30° C. and −20° C., the points are located near (*c*), and for temperatures between −20° C. and about −30° C. they are found between (*c*) and (*b*) while for higher temperatures they are grouped around (*b*), and the few points whose temperatures are greater than 10° C. are found between (*a*) and (*b*). Some of the values of the atmospheric radiation are undoubtedly too large, since 2/10 clouds and also local smoke and light fog were included in the clear weather observations in order to provide a larger number.

The second method used to check *curves* (*b*) and (*c*) was to plot all clear weather atmospheric radiation measurements (including 2/10 clouds, light fog and smoke) against mean temperatures of surface layers of air containing 0.15 mm. and 1 mm., respectively, of precipitable H_2O, and is open to error in the following way: Since the surface temperature inversion layer is usually several hundred meters thick, the mean temperatures of layers containing the above amounts of precipitable H_2O are almost always several degrees too low compared with the mean temperatures of such layers located at greater heights above the ground, and this fact will be especially true of the layer containing 0.15 mm. These cold surface layers will not ordinarily be in radiative equilibrium, since they will be subjected to radiation coming from the ground and from the warmer layer of air above it. Consequently if radiative influences alone were considered, the temperature of this surface layer would increase until it reached the equilibrium value. However, other and nonradiative influences prevent the attainment of equilibrium temperatures in the surface layer. Hence, in figures 6 and 7 the points are displaced too far to the left. In both figures the points are closer to their respective curves at low temperatures and depart from them at higher temperatures as was noticed also in figure 5. The points are grouped closer to *curve* (*b*) than to (*c*), although at low temperatures there are a considerable number of points below (*b*).

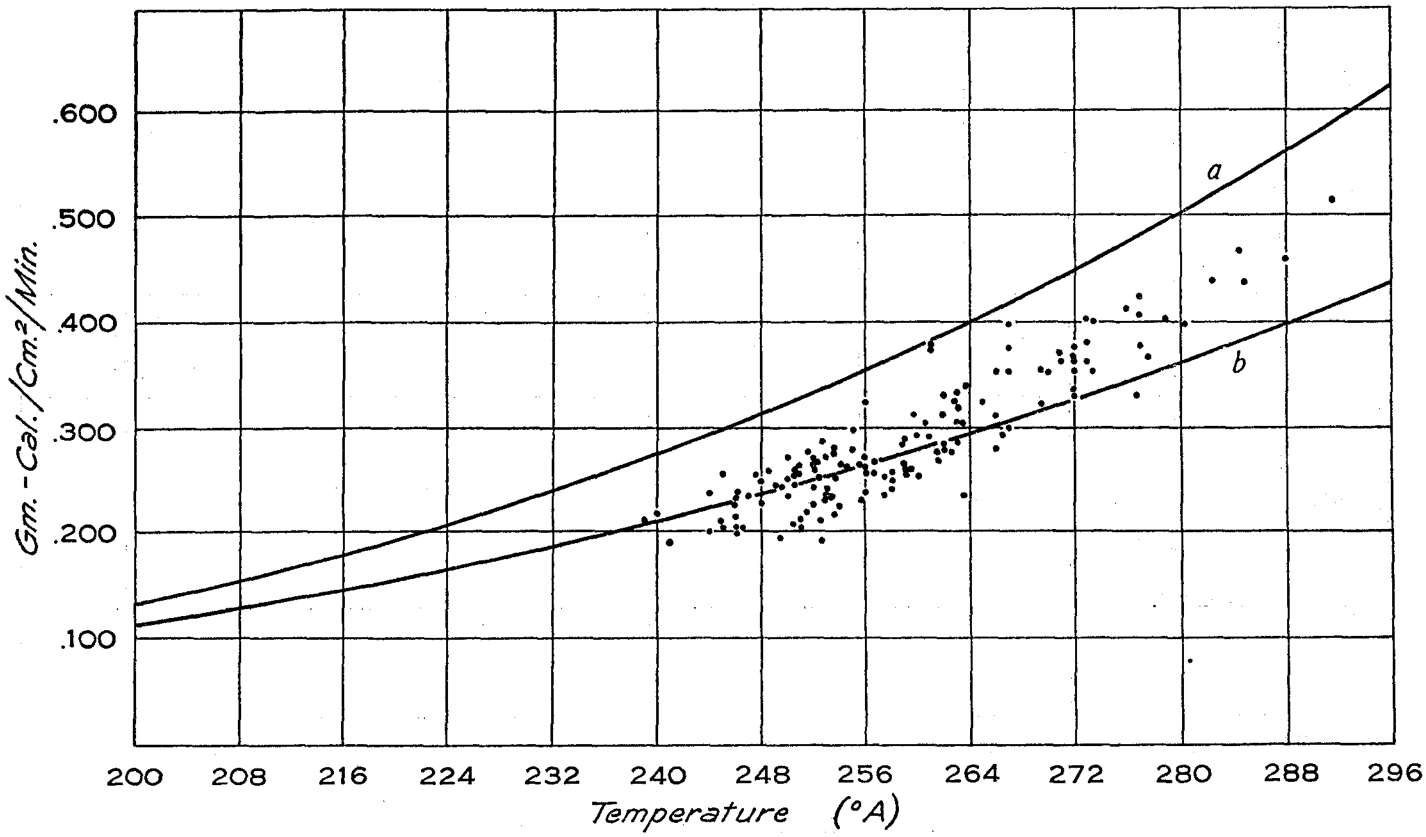

FIGURE 6.—Theoretical radiation compared with observed values.

Recently, Elsasser has devised a radiation diagram [4] based on the water vapor absorption coefficients of Weber and Randall. This diagram, which enables one to compute the radiation flux in an atmosphere of known temperature and moisture distribution, is similar to an earlier one by Mügge and Möller (1932) who used the Hettner steam absorption coefficients as reduced by Albrecht (1930) by comparison with Fowle's measurements (1917). In testing the latter diagram against observations, a large discrepancy was discovered which led to the conclusion that even the reduced Hettner coefficients were unsuited for atmospheric radiation computations and that they give too large values for atmospheric absorptivity or emissivity. In a later paper (1935), Möller attempted to overcome this difficulty by "opening-up" the water vapor absorption spectrum in an empirical manner, thus rendering the atmosphere more transparent to longwave radiation. In

[4] The manuscript describing the preparation of this diagram is as yet unpublished.

this way the necessity for having the major portion of the radiation leaving the atmosphere directly to space from the upper portion of the troposphere—or from the so-called "emission layer"—was overcome. Thus the layer of maximum cooling by radiation was brought down from the upper troposphere to the surface layers, which was in better agreement with meteorological evidence (Wexler 1936, 1937).

The Weber-Randall coefficients used by Elsasser showed that as expected the atmosphere actually was more transparent to long-wave radiation than was indicated by the first Mügge-Möller diagram. In fact, the distribution of atmospheric cooling by radiation found by use of the Elsasser diagram and the second Mügge-Möller diagram agree so closely that it seems as if Möller's empirical "opening-up" of the absorption spectrum was quite successful.

In the following the Elsasser diagram will be used in two ways: first, to test whether *curve* (*b*) or (*c*) of figure 5 represents more accurately the radiation coming downward from ideal polar continental atmospheres of various temperatures; and, secondly, to compare the observed outgoing radiation values with those computed by means of the aerological soundings made at the same time.

Curve (*d*) in figure 5 has been computed by use of the Elsasser diagram in the following way: the radiation coming from a saturated atmosphere in convective equilibrium with an ocean surface of 0° C. is designated by the ordinate of the extreme right-hand point of *curve* (*d*), while the ordinates of other points of this curve refer to the radiation coming from atmospheres whose lower portions are isothermal at temperatures corresponding to the abscissae of the curve and whose upper portions follow the original convective equilibrium curve. As described in an earlier paper (Wexler 1936), the transformation of air with an originally steep lapse-rate into polar continental air is thought to take place in such a manner that as radiative cooling from below proceeds, an increasingly thick isothermal layer is found above a large surface inversion of very small thickness. It is the balance of the upward radiation from the surface and the downward radiation from the atmosphere that determines the magnitude of the inversion. In *curves* (*b*), and (*c*) of figure 5, as stated earlier, the coldest type of saturated polar maritime atmosphere was assumed to be the initial atmosphere before cooling took place. *Curve* (*d*) agrees quite closely with (*c*) at higher temperatures and falls below it at lower temperatures. Another curve (*e*), has been computed for atmospheres of similar lapse-rates but of only 50 percent relative humidity throughout; this curve falls below (*d*) at higher temperatures but becomes practically coincident with it at lower temperatures. By use of (*a*) and (*d*), it is seen that the magnitude of the surface inversions under quasi-radiative equilibrium at lower temperatures will be greater than those found by means of (*a*) and (*c*).

However, the quite good agreement of (*c*) and (*d*) in the temperature range 253° to 273° represents the most important fact to be derived from figure 5, since most isothermal layers in polar continental air have their temperatures within this range. To compare the ideal magnitude of the quasi-radiative equilibrium inversions, table 2 has been prepared for the two curves, (*c*) and (*d*).

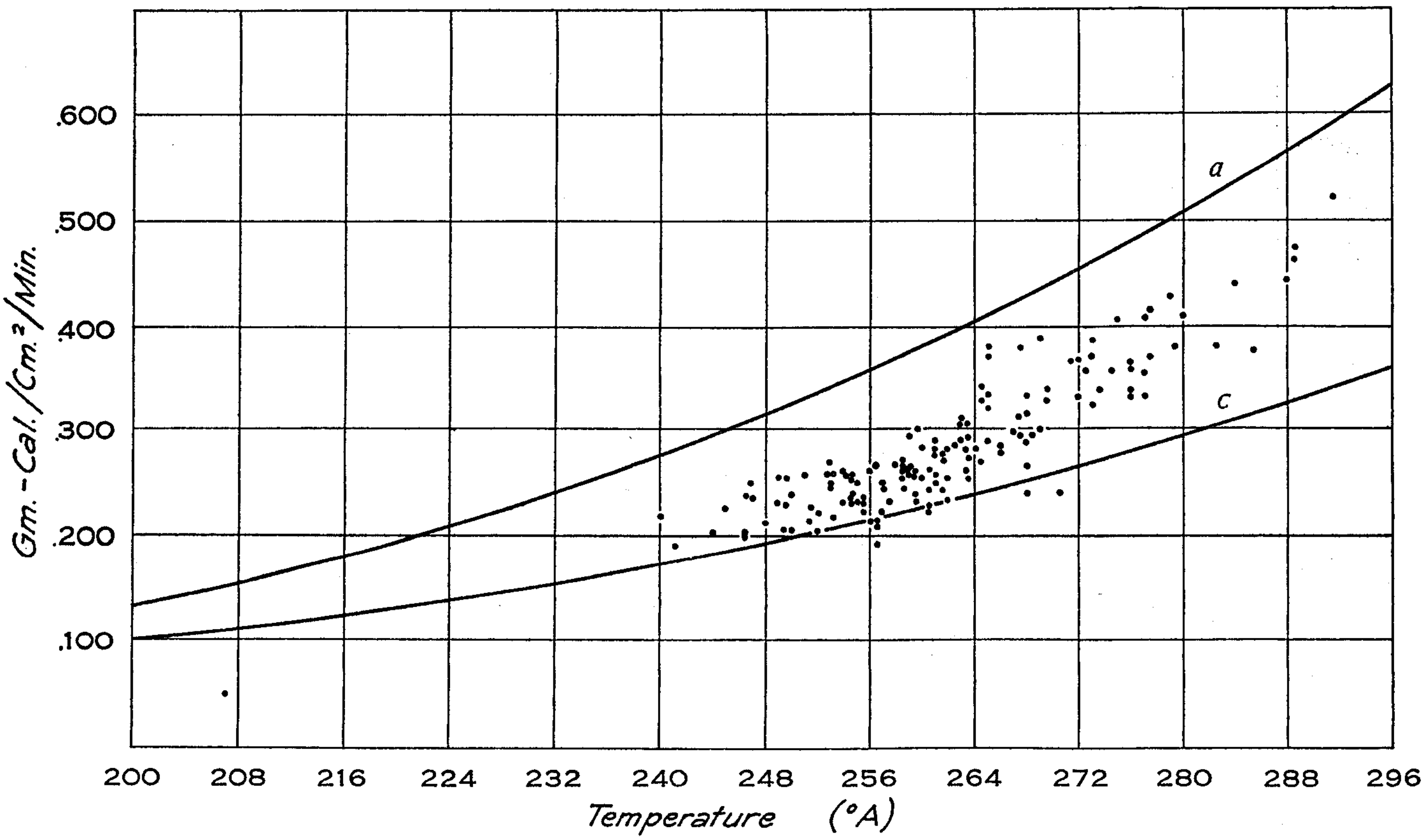

FIGURE 7.—Theoretical radiation compared with observed values.

TABLE 2.—*Comparison of ideal inversions as found from curves (c) and (d), figure 5*

Surface temperature	Isothermal temperature (curve c)	Isothermal temperature (curve d)
°C.	°C.	°C.
−30	+4	+2
−40	−9	−9
−50	−21	−16
−60	−34	−24
−70	−47	−30

The round points in figure 5, which represent the values of atmospheric radiation plotted against temperature of the isothermal layer for selected cases when these were well marked, are practically all above *(d);* this disagreement will be analyzed more thoroughly below.

To check the Elsasser diagram against observations, it was required that only data be used when two or more closely agreeing radiation measurements were made within a few hours of an aerological sounding. These conditions were met at Fairbanks only during the first winter, and at Fargo for both winters. For each sounding, two calculations on the Elsasser diagram were carried out, one for the observed moisture distribution, and the other for the moisture distribution corresponding to saturation throughout the sounding. The results are summarized in table 3, where the subscripts in column 1 refer to the number of days observations used.

TABLE 3.—*Comparison of observed and computed outgoing radiation intensities*

[Units in gm. cal./cm.²/min.]

Station	Observed	Computed	Computed (assuming saturation)
Fairbanks	0.076_{13}	0.110(45%)	0.086(13%)
Fargo	$.076_{38}$	.119(58%)	.089(17%)

The mean observed values for the two stations agree quite closely, while the computed values are about 50 percent too large, and even the values found when saturation is assumed for each sounding are too large by about 15 percent.

To show more clearly the difference between the observed and the computed values of the outgoing radiation, these values have been plotted in figure 8, where the abscissa is the difference between the *maximum* temperature observed aloft and the temperature of the air near the melikeron. The three sets of points fall for the most part on rather smooth curves, which show the expected drop in intensity with an increase in the magnitude of the temperature inversion. There is an almost constant difference of about 0.035 gm. cal./cm²/min. between the computed and the observed curves, while the curve computed on the basis of 100 percent relative humidity throughout is closer to the observed curve and drops below it at $\Delta T = 15°$. An attempt at a similar representation for Fargo did not show such a smooth array of points, although the same general trends of the curves in figure 8 were present.

The possible explanations for the discrepancy between observed and computed values are discussed below:

(a) *Presence of radiating gases in the atmosphere other than water vapor.*—Carbon dioxide (13–16μ) and ozone (9.3–10.1μ) are the only other gases that have important radiating bands in the long-wave region. Elsasser's diagram takes into account the radiation from the CO_2, all of which is assumed to originate in the lowest 200 meters of air; however, when a sharp ground inversion exists, a correction must be made for the increased CO_2 radiation caused by the higher temperature of the gas. In an unpublished paper, Elsasser has shown how to make this correction, and it turns out to be quite small when applied to the computed values, amounting to no more than a few percent. This correction which tends to decrease the computed values has already been made in the values shown in columns 2 and 3 of table 3. According to Adel (1939), the ozone band at 9.3–10.1μ has about 50 percent absorptivity for normal values of atmospheric ozone, which seems to be quite large compared to Hettner's determination. Assuming the ozone to have a mean temperature of −38°C the additional radiation sent down by the atmosphere amounts to about 0.005 gm. cal./cm.²/min.; this over-all correction has also been made in the computed values shown in columns 2 and 3.

(b) *Inaccuracy of the melikeron and errors in observation.*—Both instruments were calibrated at the Smithsonian Institution in July 1936 and again in November

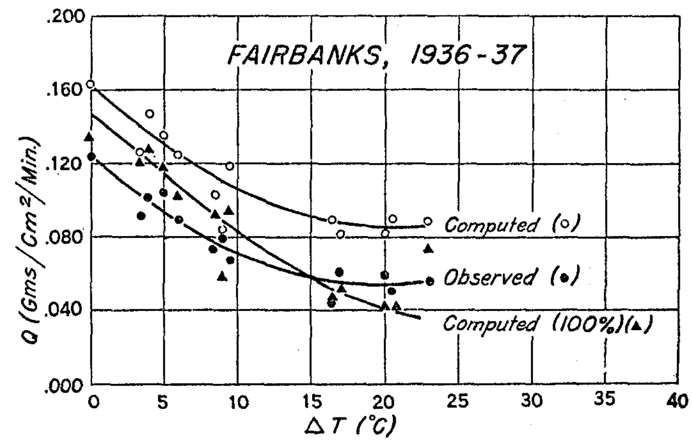

FIGURE 8.—Theoretical radiation compared with observed values.

1938, and, as mentioned before, the calibration constant, K, increased by 7 percent and 3 percent for the Fairbanks and the Fargo instruments, respectively. The earlier calibration constants were used throughout in the determinations of the outgoing radiation intensities, since most of the reduction of the data had been completed before the second calibration was made. If the larger constants had been used, then the values in column 1 of table 3 would have been 0.081 and 0.078 gm. cal./cm.²/min. for Fairbanks and Fargo, respectively, and the computed values would have still been much different from the observed values, 36 percent and 53 percent, respectively. Also as mentioned before, one of the early models of the melikeron was compared with the Ångström in actual field measurements and read only about 4 percent lower than the latter instrument. Frost deposits on the melikeron during observations can seriously affect the readings when one realizes that the deposit of a frost film of only 0.0001 cm. thick in one minute will yield an amount of heat which will compensate for the normal heat loss caused by the outgoing radiation in polar regions. The observers were warned about this source of error; and some observations, especially at Fairbanks, were abandoned because the observer could see the formation of frost or could detect it by the steady decline of his ammeter reading during successive observations. The appearance of such erroneous readings in table 3 is eliminated by the requirement that those selected were based on two or more closely agreeing successive observations.

(c) *Inaccuracy of the Elsasser radiation diagram.*—This error is difficult to determine, since it can be done only by comparison with laboratory and field measurements. In his unpublished manuscript, Elsasser claims that his computations are supported by measurements made by Strong of California Institute of Technology, who by means of a "residual ray" instrument is able to measure atmospheric infrared radiation at various bands (1939). Also he cites as support, measurements of water vapor absorption coefficients made by Adel (1939), who meas-

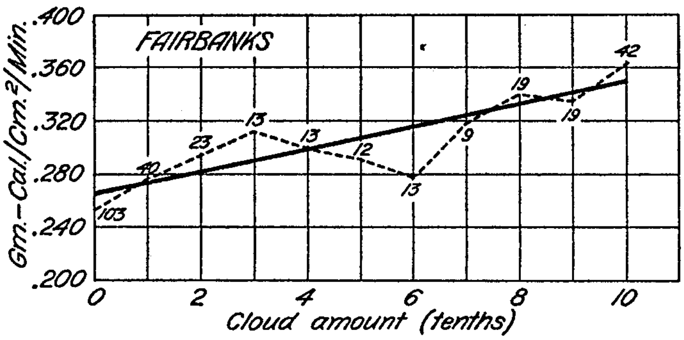

FIGURE 9.—Relation of atmospheric radiation to cloudiness.

ured the absorption of solar radiation by atmospheric water vapor. Recently F. A. Brooks, working with thin layers in the laboratory of Hottel at Massachusetts Institute of Technology, found that the measurements were not in accord with those computed on the diagram, and Elsasser admits that his diagram is probably not accurate for thin layers (of the order of 5–10 meters) but is satisfactory for thicker layers. Since the computations here involve the radiation coming from the entire atmosphere, this latter objection is of no consequence.

(d) *Presence of solid particles in the atmosphere.*—The existence of the large surface inversion over polar regions,

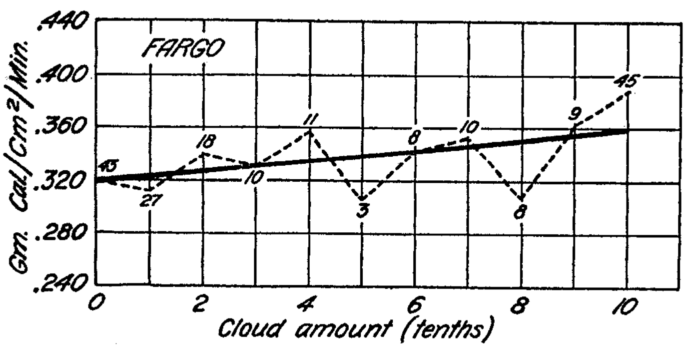

FIGURE 10.—Relation of atmospheric radiation to cloudiness.

with practically calm conditions, would favor the concentration of small solid particles in the surface layers of air, not only because of the formation of ice crystals at low temperatures, but also because the strong vertical stability of the atmosphere would prevent upward vertical diffusion of solid particles where they could then be carried away by the stronger winds aloft. It does not seem possible to estimate the effect of such solid particles, each presumably radiating as a black body, without some observations concerning concentration. However, F. A. Brooks, in a conversation with the author, told how a California fruit orchard smoke cloud, produced by smudge-pots, reduced the outgoing radiation by 40 percent. Accepting this value as typical of a very large concentration of soot particles, the effect of a much smaller concentration of ice and other particles on the outgoing radiation would seem to be much smaller than 40 percent. The values in column 1 of table 3 are about 30 to 40 percent smaller than those in column 2; if we accept the latter values as the correct ones then the apparent 30 to 40 percent reduction would seem to be much too large in view of the very much smaller concentration of solid particles in the polar regions as compared with that in orchard smoke-clouds. Finally, it should also be pointed out that not all observations at Fargo were made under conditions of strong inversions; several were made when rather steep lapse-rates prevailed in the surface layers, and yet not one case was observed when the computed values of the outgoing radiation equalled the observed value.

Unfortunately, it is not possible to compare the computed and the observed radiation values for the *Maud*, since the soundings were only about 1,500 meters high; and it is likewise impossible to compare those for Franz-Joseph Land and Mount Nordenskiöld because of lack of soundings simultaneous with the radiation measurements.

Although no definite conclusion has been reached concerning the discrepancy between computed and observed values for Fairbanks and Fargo, it is hoped that other investigations will be made to see whether in Polar and in other atmospheres there exist additional constituents—gaseous or solid—which reduce the outgoing radiation more than would be expected from the presence only of water vapor, plus small amounts of carbon dioxide and ozone.

RELATION OF ATMOSPHERIC RADIATION TO CLOUDINESS

In figures 9 and 10 are plotted values of atmospheric radiation against cloud amount, for Fairbanks and Fargo, respectively. Because of the sparseness of the data, no attempt was made to prepare such diagrams for each cloud type; even when all cloud types are grouped together, the scarcity of the observations is evident in the jagged character of the curves. The straight lines found by the least-square method show the expected increase in atmospheric radiation with cloud amount. For Fairbanks and Fargo, respectively, the equations of these lines are:

$$R_A=0.265\ (1+0.031\ M),$$

$$R_A=0.319\ (1+0.013\ M),$$

where R_A is the atmospheric radiation, and M is the cloud amount in tenths of the sky covered.

For each cloud amount, the atmospheric radiation is greater at Fargo than at Fairbanks, thus indicating that the clouds over Fairbanks are either at a lower temperature or are less dense than those over Fargo; that the latter may be the case is borne out by the pilot of the Fairbanks aerological airplane, who noted exceptionally good vertical and oblique visibilities through clouds that from the ground, might have been expected to be quite opaque. The apparent decrease northward in cloud density has been noted by Olsson (1936), who compared the Mount Nordenskiöld observations with those made at lower latitudes by Ångström. These two investigators plotted cloud amount against the outgoing radiation, instead of the atmospheric radiation. However, it seems that use of the latter quantity would eliminate the effect of surface temperature, since for the same value of atmospheric radiation the surface having the lower temperature will have the smaller amount of outgoing radiation. Once the value of the surface temperature is given, then figures 9 and 10 may be used to give the approximate dependency of outgoing radiation on cloud amount for the two stations in winter.

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TABLES OF OBSERVATIONAL DATA

Tables 4 and 5 show the outgoing radiation measurements (Q) for Fairbanks, Alaska, and Fargo, N. Dak. Each table is divided into three parts: 0–2/10 cloudiness, 3/10–6/10 cloudiness, and 7/10–10/10 cloudiness. The time is local time. Radiation units are gm. cal./cm.^{2}/min. The temperature (t) refers to that of the air in the immediate neighborhood of the melikeron. The symbols in the cloudiness column have the following meanings: S, light smoke; S +, dense smoke; =, light fog; ≡, dense fog. The abbreviations for character of the snow surface are: NL for new light; OL for old light; ND for new dense; OD for old dense; NC for new crusted; OC for old crusted; and OG for old granular. The snow surface temperatures were determined by placing an alcohol thermometer horizontally on the snow, the bulb being barely covered by the snow.

TABLE 4.—*Outgoing radiation, Fairbanks, Alaska*

PART I.—0–2/10 CLOUDINESS

Date	Local time	Q.	t.	Cloudiness: Amount	Cloudiness: Kind	Wind, direction—velocity (m. p. s.)	Snow surface: Depth (cm.)	Snow surface: Character of top layer	Snow surface: Temperature
1936		*Gm. cal./cm.²/min.*	*°C.*						*°C.*
Oct. 6	23:15	0.107	−9.5	0		N-1.0	3	NL	−11.7
Oct. 7	00:25	.080	−10.0	0		N-1.8	3	NL	−11.7
	01:30	.082	−10.1	0		N-1.8	3	NL	−11.9
Oct. 8	05:30	.079	−18.5	1	A. St.	C	2	OD	−25.3
	06:15	.079	−18.6	1	A. St.	C	2	OD	−25.6
Oct. 29	06:30	.102	−11.6	2	St.	SE-1.0	3	NL	−18.5
	07:00	.101	−12.5	2	St.	SW-1.0	3	NL	−18.8
Nov. 5	07:00	.076	−14.3	Few	St.	N-1.0	5	OD	−17.0
	07:30	.073	−14.3	Few	St.	N-1.0	5	OD	−17.2
Nov. 16	09:00	.068	−29.4	2	St.	W-1.0	28	OL	−38.8
Nov. 27	08:30	.055	−14.8	Few	St.	N-1.0	25	OC	−21.0
	09:00	.042	−16.4	Few 1	St. Ci. St.	C	25	OC	−21.0
Nov. 28	09:00	.047	−21.6	Few 1	St. Ci. St.	E-1.0	25	OO	−26.0
	10:00	.042	−21.0	Few	St.	N-1.0	25	OC	−26.8
Nov. 29	09:30	.074	−11.4	0		N-1.0	25	OO	−17.7
	10:00	.073	−11.5	0		N-1.0	25	OC	−17.7
Dec. 1	17:00	.054	−27.8	0		N-1.0	29	NL	−30.2
	18:10	.068	−27.9	0		N-1.0	29	NL	−30.5
	20:15	.063	−28.4	0		N-1.0	29	NL	−31.4
	23:15	.062	−30.5	0		N-1.0	29	NL	−31.0
Dec. 2	08:30	.050	−32.0	S		NE-1.0	29	NL	−30.5
	09:30	.052	−32.5	S		NW-1.0	29	NL	−31.0
Dec. 3	08:30	.058	−30.7	0		C	28	OL	−31.0
	09:30	.057	−31.4	0		S-1.0	28	OL	−31.0
Dec. 4	08:30	.074	−30.5	0		N-1.0	28	OL	−38.8
	10:00	.054	−28.0	0		N-1.0	28	OL	−38.5
Dec. 5	07:00	.046	−25.8	2	A. St.	N-1.0	28	OD	−31.8
Dec. 6	09:00	.052	−30.0	2	St.	C	28	OD	−36.1
Dec. 16	11:00	.057	−34.5	Few	St, S.	C	28	OD	−37.7
	12:00	.056	−35.0	2	St, S.	N-1.0	28	OD	−36.2
Dec. 18	22:30	.057	−36.5	0		N-1.0	41	NL	−42.0
	23:45	.063	−36.8	0		N-1.0	41	NL	−42.5
Dec. 19	09:15	.048	−41.2	S=		N-1.0	41	NL	−42.5
	09:30	.038	−41.3	S=		N-1.0	41	NL	−42.3
	16:30	.034	−41.0	S=		E-1.0	41	OL	−42.1
	17:00	.034	−41.1	S=		E-1.0	41	OL	−42.0
Dec. 20	10:00	.033	−38.8	S		C	41	OL	−41.0
	23:45	.022	−38.3	S		N-1.0	41	OL	−42.8

TABLE 4.—*Outgoing radiation, Fairbanks, Alaska*—Continued

PART I.—0-2/10 CLOUDINESS—Continued

Date	Local time	Q.	t.	Cloudiness: Amount	Cloudiness: Kind	Wind, direction—velocity (m. p. s.)	Snow surface: Depth (cm.)	Snow surface: Character of top layer	Snow surface: Temperature
1936		*Gm./ca./cm.²/mm.*							*°C.*
Dec. 21	01:15	0.035	−35.6	S		NW-1.0	41	OL	−42.3
	10:00	.042	−39.8	S		N-1.0	41	OL	−44.0
	10:45	.061	−39.2	S		N-1.0	41	OL	−44.2
	22:30	.040	−41.7	S		N-1.0	41	OL	−45.0
	23:30	.038	−42.2	S		N-1.0	41	OL	−44.0
Dec. 23	09:00	.030	−35.6	S		C	41	OL	−37.4
	09:30	.030	−35.8	S		C	41	OL	−37.4
Dec. 24	04:00	.038	−34.2	0		C	41	OL	−39.0
	05:00	.038	−33.8	0		N-1.0	41	OL	−39.0
	09:00	.016	−32.2	0		N-1.0	41	OL	−35.0
Dec. 25	08:20	.035	−27.6	1	A. St	C	41	OL	−33.0
	08:50	.035	−27.6	1	A. St	C	41	OL	−33.2
1937									
Jan. 8	09:00	.084	−17.0	1	St	NE-1.0	53	NL	−22.3
Jan. 15	00:30	.045	−7.5	2	St	W-1.0	69	NL	−12.4
	01:30	.016	−7.7	2	St	C	69	NL	−10.8
	18:00	.044	−4.1	2	St	SW-1.8	71	NL	−10.1
Jan. 16	22:00	.096	−10.8	0		SE-1.0	56	OD	−17.0
Jan. 17	07:30	.100	−11.9	1	St	W-2.7	56	OD	−16.5
	08:15	.106	−13.0	1	St	SW-3.6	56	OD	−17.5
	08:45	.055	−11.4	1	St	SW-3.6	56	OD	−16.4
	09:30	.069	−10.4	1	St	SW-4.5	56	OD	−15.2
	23:45	.046	−25.4	1	Ci. St, S	N-1.0	56	OD	−30.0
Jan. 18	01:00	.046	−25.4	1	Ci. St, S	N-1.0	56	OD	−30.8
	02:00	.050	−25.5	1	Ci. St, S	N-1.0	56	OD	−31.3
Jan. 22	16:00	.101	−23.8	Few	St	SW-1.0	109	NC	−30.3
	17:00	.074	−24.5	Few	St	SW-1.0	109	NC	−31.2
	20:30	.058	−26.7	0		N-1.0	109	NC	−36.0
	22:00	.066	−29.8	0		N-1.0	109	NC	−35.0
	23:30	.055	−29.5	0		N-1.0	109	NC	−34.5
Jan. 23	01:00	.028	−26.1	2	Ci. St, S	NE-1.0	109	NC	−34.8
Jan. 25	08:00	.123	−18 5	1	St	SW-2.7	107	OD	−21.2
	08:30	.124	−19.2	Few	St	SW-1.0	107	OD	−24.8
	09:00	.126	−19.2	Few	St	SW-1.0	107	OD	−26.1
	15:30	.097	−26.3	1	A. St	N-1.3	107	OD	−32.5
	16:30	.095	−28.0	1	A. St	N-1.0	107	OD	−34.9
Jan. 28	08:30	.056	−16.0	2	A. St	N-1.0	109	NL	−21.5
Jan. 30	15:30	.099	−18.8	0		NW-1.3	117	NL	−24.8
	16:30	.070	−19.3	0		NW-1.0	117	NL	−27.3
	21:30	.050	−26.0	0		N-1.0	117	NL	−30.0
	22:30	.070	−27.8	0		S-1.0	117	NL	−30.4
	23:30	.037	−26.0	0		N-1.0	117	NL	−32.0
Jan. 31	07:00	.048	−30.0	0		SE-1.0	117	OL	−32.0
	07:30	.046	−30.0	0		N-1.0	117	OL	−33.5
	08:00	.037	−29.3	0		N-1.0	117	OL	−34.0
	08:30	.037	−30.0	S=		N-1.0	117	OL	−33.9
	09:15	.019	−28.0	S=		NW-1.0	117	OL	−33.1
	09:30	.025	−27.5	S=		NW-1.0	117	OL	−33.0
	16:00	.045	−22.8	Few	Ci. St	N-1.0	117	OL	−31.8
	16:30	.076	−25.2	Few	Ci. St	C	117	OL	−33.1
	17:00	.066	−26.6	Few	Ci. St, S	C	117	OL	−33.2
Feb. 1	07:15	.011	−29.5	S		SE-1.0	117	OL	−29.8
	07:45	.017	−29.8	S		SE-1.0	117	OL	−31.8
	08:15	.021	−30.0	S		W-1.0	117	OL	−32.8
	15:30	.060	−23.7	Few	Ci. St	NW-1.0	117	OL	−30.5
	16:00	.059	−25.8	Few	Ci. St	C	117	OL	−30.5
	16:30	.061	−24.0	Few Few	Ci. St, S Ci. St	E-1.0	117	OL	−31.8
Feb. 2	15:30	.025	−19.8	Few Few	A. St Ci. St	S-1.0	117	OL	−27.4
	16:00	.062	−21.0	Few Few	A. St Ci. St	S-1.0	117	OL	−29.8
	16:30	.049	−22.0	Few	A. St	C	117	OL	−30.0
	17:30	.048	−24.0	Few	Ci. St	NE-1.0	117	OL	−30.0
Feb. 3	07:30	.029	−26.5	S		C	117	OL	−29.3
	08:00	.008	−26.0	S		C	117	OL	−29.0
	08:30	.008	−26.5	S=		N-1.0	117	OL	−29.0
	16:00	.068	−21.5	Few	A. St, S	C	117	OL	−30.1
	16:30	.048	−23.1	Few	A. St, S	C	117	OL	−29.1
	17:00	.030	−22.5	Few	A. St, S	C	117	OL	−28.0
Feb. 4	07:15	.038	−30.2	2	A. St =	N-1.0	117	OL	−32.5
	07:45	.031	−29.9	2	A. St =	N-1.0	117	OL	−34.2
	08:15	.036	−30.8	2	A. St =	N-1.0	117	OL	−34.2
	08:45	.009	−27.5	2	A. St =	NE-1.0	117	OL	−33.5
Feb. 8	19:45	.054	−17.5	2	St	S-4.0	127	NL	−20.3
	20:45	.054	−18.2	2	St	S-1.8	127	NL	−22.2
Feb. 10	07:15	.035	−36.0	1	A. St	S-1.0	128	NL	−38.2
	07:30	.034	−35.8	1	A. St	NW-1.0	128	NL	−38.8
	07:45	.034	−35.6	1	A. St	NW-1.0	128	NL	−39.2
	08:00	.035	−33.9	1	A. St	NW-1.0	128	NL	−39.9
	08:20	.049	−34.8	1	A. St	NW-1.0	128	NL	−39.5
Feb. 13	07:00	.042	−40.2	S=		N-1.0	130	NL	−42.8
	07:15	.059	−40.5	S		N-1.0	130	NL	−43.0
	07:35	.027	−38.3	S=		N-1.0	130	NL	−45.3
	07:55	.042	−38.9	S=		N-1.0	130	NL	−44.6
	08:30	.032	−39.4	S=		N-1.0	130	NL	−44.3
	16:15	.091	−27.5	Few	Ci. St	N-1.0	130	NL	−40.0
	16:30	.086	−29.5	Few	Ci. St	N-1.0	130	NL	−42.0
	16:45	.094	−30.8	Few	Ci. St	C	130	NL	−42.0
	17:00	.096	−31.1	Few	Ci. St	C	130	NL	−42.0
	18:00	.089	−32.0	0		N-1.0	130	NL	−43.5
	20:00	.063	−36.5	0		N-1.0	130	NL	−44.5
Feb. 17	16:30	.076	−32.8	1	St	NW-1.0	131	NL	−42.4
	16:55	.079	−33.2	1	St	NW-1.0	131	NL	−43.0
	17:15	.079	−34.5	1	St	NW-1.0	131	NL	−44.0
	17:45	.068	−35.6	1	St	NW-1.0	131	NL	−44.8
	18:00	.076	−37.0	1	St	NW-1.0	131	NL	−45.0

TABLE 4.—*Outgoing radiation, Fairbanks, Alaska*—Continued

PART I.—0-2/10 CLOUDINESS—Continued

Date	Local time	Q.	t.	Cloudiness		Wind, direction—velocity (m. p. s.)	Snow surface		
				Amount	Kind		Depth (cm.)	Character of top layer	Temperature
1937		*Gm. ca./cm.²/mm.*							°*C.*
Feb. 18	16:15	0.070	−29.0	0		NW-1.0	131	OL	−41.5
	16:45	.068	−31.7	0		NW-1.0	131	OL	−42.7
	17:15	.102	−33.2	0		N-1.0	131	OL	−43.7
	17:45	.063	−33.0	0		N-1.0	131	OL	−43.7
Feb. 21	06:15	.038	−28.8	2	A. St	N-1.0	131	OL	−33.0
	06:45	.040	−28.0	2	A. St	N-1.0	131	OL	−33.3
	07:15	.030	−28.8	2	A. St	C	131	OL	−33.2
	07:45	.025	−28.0	2	A. St	NW-1.0	131	OL	−33.0
Feb. 23	16:40	.086	−16.5	2	St	N-1.0	132	NL	−26.0
	17:00	.101	−17.6	2	St	C	132	NL	−25.7
	17:25	.094	−18.5	2	St	C	132	NL	−25.5
	17:45	.083	−20.2	2	St	C	132	NL	−26.0
Feb. 26	17:00	.094	−16.1	Few	A. St	NW-1.0	132	NL	−27.0
	17:15	.080	−17.0	Few	A. St	NW-1.0	132	NL	−26.0
	17:30	.102	−18.0	Few	A. St	SE-1.0	132	NL	−27.1
	18:05	.101	−18.8	Few	A. St	SW-1.0	132	NL	−26.5
	18:35	.081	−20.2	0		W-1.0	132	NL	−28.3
	19:05	.078	−20.1	0		NW-1.0	132	NL	−29.5
Mar. 1	16:45	.101	−15.8	1	St	NW-1.0	135	OL	−27.0
	17:15	.099	−16.7	1	St	N-1.0	135	OL	−27.3
	17:45	.089	−17.0	1	St	N-1.0	135	OL	−26.3
	18:15	.084	−18.2	0		NW-1.3	135	OL	−27.5
	18:45	.080	−20.0	0		N-1.0	135	OL	−28.2
Mar. 2	06:15	.022	−27.0	Few	St, S	NW-1.3	135	OL	−32.0
	06:45	.062	−27.0	Few	St, S	NW-1.0	135	OL	−35.2
	07:15	.055	−27.2	Few	St, S	NW-1.0	135	OL	−36.0
	17:00	.108	−17.5	Few	St	N-1.0	135	OL	−32.0
	17:15	.074	−17.9	Few	St	N-1.3	135	OL	−32.2
	17:30	.085	−18.0	Few	St	N-1.0	135	OL	−32.3
	18:15	.107	−22.0	Few	St	N-1.0	135	OL	−31.5
Mar. 3	06:30	.042	−30.9	Few	St	NW-1.0	135	OL	−37.5
	06:45	.040	−31.0	Few	St	NW-1.3	135	OL	−37.8
	07:00	.036	−30.8	Few	St	NW-1.3	135	OL	−38.0
	07:15	.036	−30.5	Few	St	NW-1.0	135	OL	−37.5
	07:30	.018	−32.8	Few	St	SE-1.0	135	OL	−36.5
	17:00	.115	−18.5	0		NW-1.0	135	OL	−33.8
	17:30	.096	−18.0	0		N-1.0	135	OL	−34.0
	18:00	.107	−20.6	0		N-1.3	135	OL	−34.3
	18:30	.098	−21.7	0		N-1.0	135	OL	−34.7
Mar. 8	05:30	.045	−28.0	1	St	NW-1.0	135	OL	−32.0
	05:45	.041	−28.0	1	St	NW-1.0	135	OL	−32.0
	06:00	.036	−28.2	1	St	NW-1.0	135	OL	−32.3
	06:30	.040	−28.9	1	St	N-1.0	135	OL	−34.0
	07:00	.022	−28.7	1	St, S	N-1.0	135	OL	−33.8
Mar. 12	05:10	.038	−12.0	1	Ci. St	N-1.0	136	OD	−18.9
	05:30	.042	−12.0	1	Ci. St	N-1.0	136	OD	−18.9
	05:50	.046	−12.0	1	Ci. St	N-1.0	136	OD	−18.8
	06:10	.050	−12.0	2	Ci. St	N-1.0	136	OD	−20.0
	06:30	.031	−13.0	2	Ci. St	N-1.0	136	OD	−20.0
	17:45	.100	−3.3	1	A. St	W-1.0	135	OD	−15.7
	18.00	.095	−3.3	Few	A. St	W-1.0	135	OD	−15.7
	18:15	.096	−3.6	Few	A. St	C	135	OD	−15.9
	18:30	.092	−3.8	Few	A. St	W-1.0	135	OD	−16.0
Mar. 13	05:30	.048	−15.0	Few	A. St	W-1.0	135	OD	−20.8
	06:00	.049	−15.0	Few	A. St	NW-1.0	135	OD	−20.9
	06:30	.034	−15.0	Few	A. St	NW-1.0	135	OD	−21.2
	07:00	.016	−16.5	Few	A. St	N-1.0	135	OD	−19.6
	17:30	.109	−1.0	Few	A. St	W-1.0	134	OD	−14.0
	18:00	.113	−1.6	Few	A. St	NW-1.0	134	OD	−14.7
	18:30	.115	−2.8	Few	A. St	W-1.0	134	OD	−15.3
Mar. 14	05:30	.030	−13.8	1	A. St	W-1.0	134	OD	−18.0
	05:45	.032	−14.0	1	A. St	NW-1.0	134	OD	−18.2
	06:00	.035	−14.0	1	A. St	N-1.0	134	OD	−18.6
	06:15	.034	−14.0	1	A. St	N-1.0	134	OD	−19.4
Oct. 21	22:00	.102	−4.9	Few	Ci., S	Calm	1	OG	−6.8
	22:30	.079	−4.3	Few	Ci., S	W-1.0	1	OG	−6.3
Oct. 23	06:00	.061	−8.5	2	A. Cu	W-1.0	1	OG	−11.0
	19:45	.072	−5.2	2	A. Cu	Calm	1	OG	−8.8
	19:30	.064	−5.4	Few	A. Cu	Calm	1	OG	−10.0
Oct. 26	21:00	.083	−4.4	2	A. Cu	Calm	1	OG	−10.8
	22:15	.072	−6.3	Few	A. Cu	N-1.0	1	OG	−11.9
Oct. 27	06:15	.059	−10.5	0=		Calm	1	OG	−12.7
	20:30	.076	−6.2	Few	A. St	NW-1.0	1	OG	−12.4
	22:30	.093	−7.0	Few	A. St	NW-1.0	1	OG	−13.2
Oct. 28	22:30	.043	−12.5	0		S=NW-1.0	1	OG	−13.5
Oct. 29	20:00	.083	−13.1	0		NW-1.0	1	OG	−18.0
	22:00	.072	−14.7	0	S	Calm	T	([1])	−19.0
Oct. 30	06:15	.068	−16.6	0		N-1.0	T	([1])	−20.0
	23:45	.079	−12.8	---		Calm	T	([1])	−17.0
Nov. 1	06:30	.074	−11.1	Few	A. St	Calm	T	([1])	−15.5
Nov. 2	23:00	.074	−3.9	0	S	Calm	T	([1])	−10.9
	23:30	.089	−4.0	0		N-1.0	T	([1])	−10.9
Nov. 3	20:00	.084	−2.2	0		Calm	T	([1])	−7.7
	21:30	.085	−4.9	0		Calm	T	([1])	−9.7
Nov. 4	22:30	.073	−7.0	2	St	NW-1.0	9	NL	−12.8
Nov. 5	19:30	.068	−13.3	0	S	Calm	9	NL	−17.0
Nov. 6	20:30	.025	−14.2	----	S	NW-1.0	9	NL	−16.8
Nov. 8	06:00	.079	−15.7	Few	St	Calm	10	NL	−23.0
Nov. 10	19:00	.069	−6.0	2	A. St	N-1.0	10	OL	−12.2
Nov. 12	20:00	.064	−11.3	0		NW-1.0	10	OL	−18.5
	20:30	.065	−11.2	0		Calm	10	OL	−18.9
Nov. 13	20:30	.055	−14.0	0		NW-1.0	10	OL	−19.4
	23:45	.059	−16.7	0		Calm	10	OL	−21.0
Nov. 14	06:30	.045	−17.6	0	S	NW-1.3	10	OL	−21.2
Nov. 17	19:00	.067	−17.2	0		Calm	10	NL	−22.0
Nov. 18	06:30	.049	−21.6	0		Calm	10	OL	−22.8
	19:30	.055	−20.3	0		Calm	10	OL	−23.7
	23:30	.055	−20.3	0		N-1.0	10	NL	−24.0

[1] Snow patches.

TABLE 4.—*Outgoing radiation, Fairbanks, Alaska*—Continued

PART I.—0-2/10 CLOUDINESS—Continued

Date	Local time	Q.	t.	Cloudiness		Wind, direction—velocity (m. p. s.)	Snow surface		
				Amount	Kind		Depth (cm.)	Character of top layer	Temperature
		Gm. ca./cm.²/mm.							*°C.*
1937									
Nov. 19	06:30	0.025	−21.9	0		NW-1.0	10	OL	−21.9
	23:00	.101	−14.5	0		NW-2.7	10	OL	−20.3
Nov. 20	06:30	.089	−17.7	0		NW-2.7	10	OL	−23.0
	22:00	.092	−17.6	Few	A. St.	NE-5.4	10	OL	−21.5
Nov. 21	23:00	.094	−19.4	0		NW-4.5	10	OL	−25.0
Nov. 22	06:30	.079	−20.0	1	A. St.	NW-1.8	10	OL	−24.4
	23:45	.078	−16.6	Few	A. St.	W-1.	10	OL	−22.0
Nov. 23	20:00	.084	−11.5	0		N-1.8	10	OL	−19.0
Nov. 24	06:30	.089	−14.2	0		NW-2.7	10	OL	−20.3
	20:00	.106	−17.6	0		N-2.7	10	OL	−23.0
	22:00	.092	−15.7	0		N-2.7	10	OL	−22.2
Nov. 25	23:00	.074	−13.5	1	A. St.	NE-1.0	10	OL	−20.0
	23:30	.074	−13.4	0	S.	NE-1.0	10	OL	−20.0
Nov. 27	23:30	.039	−20.3	0	S.	E-1.0	10	OL	−26.0
	23:45	.040	−20.3	0	S.	E-1.0	10	OL	−26.2
Nov. 28	06:30	.050	−27.2	Few	A. St.	NW-1.0	10	OL	−26.7
	21:00	.035	−16.2	0	S.	E-1.0	10	OL	−20.3
	23:00	.049	−16.7	1	A. St.	W-1.0	10	OL	−22.0
Dec. 9	21:30	.085	−20.5	0		N-1.0	18	OL	−28.8
	22:30	.092	−20.2	0		NE-1.8	18	OL	−29.0
Dec. 10	22:45	.069	−35.2	Few	A. St.	N-1.0	18	OL	−40.2
	23:15	.066	−35.5	Few	A. St.	N-1.0	18	OL	−41.5
Dec. 15	23:15	.036	−24.3	0		W-1.0	18	OL	−27.2
	23:45	.042	−24.0	0		W-1.0	18	OL	−27.3
Dec. 16	22:00	.031	−26.0	0		N-1.0	18	OL	−29.0
	22:30	.031	−26.0	0		NW-1.0	18	OL	−28.8
	23:00	.032	−26.2	0	S.	NW-1.0	18	OL	−28.2
Dec. 17	20:00	.038	−25.6	0		N-1.0	18	OL	−29.5
	21:00	.037	−26.5	0		N-1.0	18	OL	−29.9
	22:00	.039	−26.5	0		E-1.0	18	OL	−29.4
Dec. 23	23:15	.064	−15.8	0	S.	NW-1.0	25	NL	−19.8
	23:35	.060	−16.5	0	S.	NW-1.0	25	NL	−21.2
Dec. 24	06:45	.055	−27.0	0		NW-1.0	25	OL	−32.0
Dec. 26	23:15	.025	−32.0	0		E-1.0	25	OL	−36.2
	23:45	.023	−32.2	0		Calm	25	OL	−36.0
Dec. 27	23:10	.065	−33.0	0	S.	E-1.0	25	OL	−42.0
	23:45	.073	−34.9	0	S.	E-1.8	25	OL	−43.9
Dec. 28	06:45	.050	−37.8	0	S.	SW-1.8	25	OL	−45.0
	07:00	.053	−38.0	0	S.	SW-1.8	25	OL	−44.8
	22:30	.050	−38.9	0	S.	E-1.8	25	OL	−43.0
	23:00	.060	−38.7	0	S.	N-1.0	25	OL	−44.3
	23:20	.057	−39.0	0	S.	NE-1.0	25	OL	−45.0
Dec. 29	07:00	.073	−29.4	0	S.	NE-1.0	25	OL	−34.0
	20:00	.049	−32.0	0	S.	NW-1.8	25	OL	−34.0
Dec. 30	22:45	.056	−32.2	0	S.	N-1.0	25	OL	−36.5
Dec. 31	18:50	.081	−30.8	0	S.	N-1.0	25	OL	−37.0
1938									
Jan. 1	01:45	.055	−38.8	0	S.	S-1.0	25	OL	−41.0
Jan. 2	19:00	.054	−31.9	0	S.	Calm	25	OL	−32.9
	23:00	.042	−29.6	0	S.	N-1.0	25	OL	−30.8
Jan. 4	23:15	.038	−26.5	0		Calm	36	NL	−31.3
	23:35	.035	−26.7	0		N-1.0	36	NL	−32.0
Jan. 5	23:30	.031	−13.5	Few	A. St. S.	N-1.0	36	OL	−18.5
Jan. 6	22:00	.019	−19.5	0	S.	N-1.0	36	OL	−23.3
	23:00	.020	−20.3	0	S.	N-1.0	36	OL	−22.8
Jan. 7	22:30	.050	−15.2	0	S.	N-1.0	36	OL	−20.1
	22:45	.052	−15.0	0	S.	N-1.0	36	OL	−20.3
Jan. 9	23:00	.079	−31.5	0		E-1.8	20	OD	−40.5
	23:45	.081	−32.0	0		E-1.0	20	OD	−39.8
Jan. 10	21:00	.049	−37.8	0		S-1.8	20	OD	−41.0
	23:00	.046	−38.9	0		S-1.8	20	OD	−42.0
Jan. 11	20:15	.066	−35.2	0		W-1.8	20	OD	−42.2
	23:20	.064	−34.0	0	S.	N-1.8	20	OD	−43.0
Jan. 12	20:15	.055	−34.8	0	S.	NW-1.0	20	OD	−42.0
	23:15	.055	−36.8	0	S.	Calm	20	OD	−43.5
Jan. 13	20:20	.033	−36.5	0	S.	N-1.0	20	OD	−44.2
Jan. 18	20:10	.036	−28.0	0		Calm	20	OD	−30.5
	21:40	.038	−28.5	0		N-1.0	20	OD	−31.6
Jan. 23	23:20	.042	−38.7	0		N-1.0	28	NL	−42.8
	23:45	.042	−38.5	0		N-1.0	28	OL	−43.2
Jan. 24	20:10	.035	−38.2	0	S.	Calm	28	OL	−41.7
	23:30	.029	−39.5	0	S.	Calm	28	OL	−40.3
Jan. 25	22:15	.034	−38.6	0	S.	Calm	28	OL	−39.4
	22:45	.032	−38.8	0	S.	NE-1.0	28	OL	−40.0
Jan. 26	21:00	.036	−34.0	0	S.	Calm	28	OL	−38.2
	23:45	.029	−34.3	0	S.	N-1.0	28	OL	−38.5
Jan. 27	20:30	.044	−33.7	0	S.	N-1.8	28	OL	−39.3
Jan. 28	00:30	.028	−30.4	0	S.	W-1.0	28	OL	−34.0
	20:30	.042	−35.5	0	S.	N-1.0	28	OL	−39.9
	22:00	.040	−35.8	0	S.	W-1.0	28	OL	−40.8
Jan. 31	22:00	.042	−32.2	0		N-1.0	34	NL	−38.0
	22:30	.046	−32.8	0		N-1.0	34	NL	−38.2
Feb. 3	22:15	.059	−31.0	0		N-1.0	36	NL	−33.6
	22:45	.064	−31.6	0		Calm	36	NL	−33.8
Feb. 4	19:30	.049	−37.6	0	S.	N-1.0	36	OL	−44.0
	23:30	.042	−41.2	0	S.	N-1.0	30	OL	−45.0
Feb. 5	23:00	.043	−42.3	0	S.	N-1.0	36	OL	−46.0
	23:15	.042	−43.2	0	S.	Calm	36	OL	−45.8
Feb. 6	22:00	.036	−40.8	0	S.	Calm	36	OL	−41.8
	22:30	.035	−41.2	0	S.	Calm	36	OL	−41.8
Feb. 7	20:30	.050	−39.8	0		N-1.0	36	OL	−45.1
	21:10	.049	−40.0	0		N-1.0	36	OL	−46.7
Feb. 8	23:30	.035	−38.9	0		NE-1.0	36	OL	−42.2
Feb. 10	23:50	.035	−34.5	0		N-1.0	44	NL	−41.5
Feb. 11	00:30	.032	−35.4	0		N-1.0	44	OL	−41.7
	23:00	.029	−35.3	0		S-1.0	44	OL	−39.1

TABLE 4.—*Outgoing radiation, Fairbanks, Alaska*—Continued

PART I.—0-2/10 CLOUDINESS—Continued

Date	Local time	Q.	t.	Cloudiness: Amount	Cloudiness: Kind	Wind, direction—velocity (m. p. s.)	Snow surface: Depth (cm.)	Snow surface: Character of top layer	Snow surface: Temperature
1938		*Gm. ca./cm.²/mm.*							*°C.*
Feb. 12	20:00	0.050	−29.4	0		Calm	44	OL	−35.7
	22:00	.042	−28.5	0		N-1.0	44	OL	−35.0
Feb. 13	20:00	.046	−27.5	0		Calm	44	OL	−33.0
	23:00	.036	−28.1	0	S.	Calm	44	OL	−32.6
Feb. 14	20:00	.059	−25.1	0		N-1.0	44	OL	−30.5
	23:15	.051	−27.8	0	S.	E-1.0	44	OL	−32.0
Feb. 15	23:00	.051	−28.5	0		N-1.0	44	OL	−32.9
Feb. 16	00:15	.049	−26.4	0		N-1.0	44	OL	−34.2
Feb. 17	00:45	.045	−31.2	0	S.	N-1.0	44	OL	−37.0
	20:30	.050	−28.5	0		N-1.0	44	OL	−32.2
	23:50	.045	−32.0	0		N-1.0	44	OL	−35.0
Feb. 18	21:00	.079	−19.5	0		N-1.0	43	OL	−26.0
Feb. 19	23:50	.082	−24.4	0		E-1.8	43	OD	−31.2
Feb. 20	21:45	.022	−21.4	0		N-1.0	43	OD	−25.4
	23:00	.053	−24.2	0		Calm	43	OD	−29.4
Feb. 22	20:00	.051	−15.3	0		Calm	43	OD	−19.6
	21:00	.050	−15.8	0		Calm	43	OD	−20.2
Mar. 1	21:00	.050	−7.4	0		NW-1.0	48	NL	−15.0
	21:15	.052	−7.5	0		NW-1.0	48	NL	−15.0
Mar. 2	23:00	.055	−10.9	0		Calm	48	OC	−17.0
	23:30	.057	−11.6	0		NW-1.0	48	OC	−17.5
Mar. 3	20:15	.050	−10.0	0		N-1.0	43	OC	−17.0
	23:45	.042	−14.8	0		N-1.0	43	OC	−20.0
Mar. 4	20:00	.055	−12.5	0		N-1.0	38	OD	−19.4
	23:50	.051	−15.2	0	S.	N-1.0	38	OD	−21.8
Mar. 6	23:00	.059	−10.1	2	A. St.	Calm	38	OD	−16.1
Mar. 7	23:45	.050	−15.4	0		Calm	38	OD	−22.8
Mar. 8	20:00	.089	−9.4	0		Calm	38	OD	−19.7
	23:30	.068	−13.0	0		N-1.0	38	OD	−21.8
Mar. 9	23:30	.055	−12.3	2	A. St.	N-1.0	38	OD	−19.4
Mar. 12	21:30	.089	−12.0	0		NE-1.8	41	OL	−21.1
Mar. 13	21:30	.084	−14.8	0		Calm	41	OL	−23.8
Mar. 14	21:30	.092	−15.7	2	Ci. St.	Calm	38	OD	−22.3
Mar. 16	23:00	.060	−21.8	2	A. St.	N-1.0	39	NL	−26.7
PART II.—3/10-6/10 CLOUDINESS									
1936									
Oct. 29	02:35	0.101	−8.0	6	St. Cu.	W-1.3	3	NL	−7.8
Nov. 14	08:00	.066	−19.9	6	St.	N-1.0	28	OL	−19.9
	08:30	.065	−20.0	6	St.	N-1.0	28	OL	−20.2
Dec. 5	00:30	.026	−26.0	4	A. St.	N-1.0	28	OL	−31.2
Dec. 6	09:30	.052	−31.6	1 3	Ci. St. St.	C	28	OL	−35.8
Dec. 24	22:00	.021	−29.8	6	A. St.	N-1.0	41	OL	−33.4
	22:30	.020	−29.8	6	A. St.	N-1.0	41	OL	−33.3
Dec. 26	22:30	.013	−18.0	6	A. St.	E-3.6	41	NL	−23.5
1937									
Jan. 4	08:30	.035	−20.3	6	Ci. St, S.	N-1.0	52	NL	−25.2
	09:00	.036	−20.0	6	Ci. St., S.	N-1.0	52	NL	−25.2
	22:00	.034	−19.2	5	A. St., S.	E-1.0	52	NL	−21.2
Jan. 8	09:30	.073	−18.5	6	St.	NE-1.0	53	NL	−23.5
Jan. 12	14:45	.120	−19.0	2 4	Ci. St. St.	S-1.0	51	OC	−27.0
	22:00	.016	−18.0	4	St.	NE-1.8	51	OC	−21.0
	23:30	.019	−17.0	5	St.	N-2.7	51	OC	−19.0
Jan. 15	17:00	.089	−4.5	3	St.	NE-1.0	71	NL	−10.2
	19:00	.008	−1.7	6	St.	E-1.0	71	NL	−5.8
Jan. 16	23:30	.045	−11.6	3	St.	N-1.0	56	OD	−15.8
Jan. 17	19:30	.090	−22.2	3	Ci. St.	C	56	OD	−29.0
	20:30	.086	−21.5	3	Ci. St.	C	56	OD	−30.5
	21:00	.100	−23.0	3	Ci. St.	N-1.0	56	OD	−30.8
Jan. 23	02:00	.054	−22.3	4	Ci. St.	N-2.7	109	NC	−26.8
Jan. 25	17:30	.064	−29.0	3	A. St.	N-1.3	107	OD	−32.2
	18:30	.062	−30.0	3	A. St., S.	C	107	OD	−33.9
	21:00	.042	−30.0	4	A. St., S.	N-1.0	107	OD	−33.1
	22:00	.030	−29.6	5	A. St., S.	C	107	OD	−32.8
Jan. 27	07:30	.026	−19.0	2 2	Ci. St. A. St.	N-1.3	108	NL	−22.0
	08:00	.048	−18.0	3 3	Ci. St. A. St.	NW-1.0	108	NL	−25.0
Jan. 28	07:30	.062	−14.8	5	A. St.	E-1.0	109	NL	−18.0
	08:00	.056	−12.8	5	A. St.	NW-1.0	109	NL	−21.3
Jan. 29	17:30	.055	−5.9	4	St.	SW-5.4	117	NL	−8.9
	18:30	.055	−6.1	4	St.	SW-4.5	117	NL	−9.0
Feb. 11	16:00	.055	−24.2	5	St.	C	130	NL	−28.1
	16:30	.055	−26.0	5	St.	C	130	NL	−33.4
	17:00	.080	−26.4	5	St.	C	130	NL	−36.0
	17:15	.079	−28.0	5	St.	S-1.0	130	NL	−36.0
	17:30	.080	−27.8	5	St.	S-1.0	130	NL	−37.6
Feb. 15	08:25	.055	−26.1	5 1	A. St. St.	NE-1.0	131	NL	−33.8
	08:45	.030	−25.8	5 1	A. St. St.	NE-1.0	131	NL	−34.5
Feb. 16	17:45	.083	−31.0	5 1	A. St. St.	N-1.0	131	NL	−38.5
	18:00	.080	−31.2	5 1	A. St. St., S.	C	131	NL	−38.0
Feb. 19	18:00	.084	−20.2	6	A. St.	N-1.0	131	NL	−26.5
Feb. 20	07:00	.038	−28.5	6	Ci. St.	NW-1.0	131	OL	−33.9
	07:30	.019	−28.0	6	Ci. St.	N-1.0	131	OL	−34.2
	08:00	.019	−27.0	5	Ci. St.	NW-1.0	131	OL	−34.0
	16:30	.066	−19.0	5	A. St.	C	131	OL	−26.5
	17:00	.062	−19.0	5	A. St.	C	131	OL	−27.1
	17:30	.054	−19.8	4	A. St.	N-1.0	131	OL	−27.8
	18:00	.034	−20.4	4	A. St.	C	131	OL	−27.0

TABLE 4.—*Outgoing radiation, Fairbanks, Alaska*—Continued

PART II.—3/10-6/10 CLOUDINESS—Continued

Date	Local time	Q.	t.	Cloudiness		Wind, direction—velocity (m. p. s.)	Snow surface		
				Amount	Kind		Depth (cm.)	Character of top layer	Temperature
		Gm./cal./cm.²/mm.							*°C.*
1937									
Feb. 21	16:30	0.072	−21.0	4	St	C	131	OL	−29.6
	17:00	.068	−20.9	4	St	NE-1.0	131	OL	−29.7
	17:30	.046	−21.5	4	St	C	131	OL	−29.6
	18:00	.038	−22.4	4	St	C	131	OL	−29.4
Mar. 4	05:30	.064	−32.8	6	St	NW-1.0	135	OL	−39.0
Mar. 7	17:00	.072	−20.4	5	St	SE-1.0	135	OL	−25.0
	17:30	.056	−20.7	5	St	SE-1.0	135	OL	−26.0
	18:00	.055	−20.8	4	St	SE-1.0	135	OL	−26.6
Mar. 9	18:50	.050	−19.8	5	A. St	N-1.0	135	OL	−24.3
Mar. 10	05:30	.035	−26.1	3	A. St	NW-1.0	136	NL	−28.0
	05:50	.032	−26.3	3	A. St, S	NW-1.0	136	NL	−28.3
	06:10	.032	−26.8	5	St. S	N-1.0	136	NL	−28.8
	06:30	.018	−25.7	5	St. S	C	136	NL	−28.9
	07:00	.018	−26.0	3 3	A. St St	C	136	NL	−28.5
Mar. 14	17:15	.064	2.5	2 3	A. St St	NE-2.2	133	OD	−7.0
	17:30	.064	2.4	2 3	A. St St	NE-2.2	133	OD	−7.2
	18:30	.075	1.8	2 3	A. St St	NE-1.8	133	OD	−5.0
Oct. 21	06:15	.078	−7.0	3	St. Cu	Calm	1	OG	−8.1
Oct. 23	22:30	.060	−6.4	6	A. St., S	N-1.0	1	OG	−10.4
Oct. 26	20:00	.066	−3.2	3	A. Cu	E-1.0	1	OG	−8.2
Nov. 1	19:30	.046	−4.2	4	A. Cu	NW-1.0	1	OG	−8.6
Nov. 9	20:30	.025	−5.0	6	A. St	NW-1.0	10	OL	−7.7
Nov. 10	22:30	.010	−6.7	3	A. St., S	N-1.0	10	OL	−8.8
Nov. 15	21:00	.066	−11.7	3	A. St	W-1.8	10	OL	−19.0
Nov. 17	23:00	.049	−19.0	1	A. St. (overhead)	N-1.0	10	NL	−21.6
Nov. 22	20:15	.011	−14.0	3	A. St	NE-1.0	10	OL	−16.0
Dec. 19	22:45	.059	−8.3	5	A. St	Calm	20	NL	−14.9
	23:15	.061	−8.5	4	A. St	Calm	20	NL	−14.9
Dec. 22	19:30	.025	−13.5	5	A. St	NE-1.0	20	OC	−15.0
	23:30	.033	−13.1	3	A. St	S-1.0	20	OC	−15.8
Dec. 25	19:45	.003	−26.0	4	A. St	N-1.0	25	OL	−25.2
	20:45	.017	−24.9	4	A. St., S	Calm	25	OL	−23.5
1938									
Jan. 14	20:30	.035	−34.3	4	A. St	NW-1.0	20	OD	−39.0
Jan. 15	01:30	.031	−34.5	5	A. St	N-1.0	20	OD	−40.0
Jan. 16	21:00	.050	−19.2	6	A. St	NE-1.0	20	OD	−23.5
	23:30	.049	−20.7	5	A. St	Calm	20	OD	−25.5
Mar. 17	23:00	.051	−19.8	3	A. St	N-1.8	38	OD	−24.3
Mar. 19	23:00	.026	−18.2	4	A. St	SW-1.0	38	OD	−19.2

PART III.—7/10-10/10 CLOUDINESS

Date	Local time	Q.	t.	Amount	Kind	Wind, direction—velocity (m. p. s.)	Depth (cm.)	Character of top layer	Temperature
1936									
Oct. 9	05:15	0.080	−1.0	7	St	NE-1.8	1	OD	−7.5
	06:30	.058	−1.2	7	St	NE-1.0	1	OD	−7.5
Oct. 14	05:30	.044	−1.0	10	St	S-1.0	4	NL	−1.0
	06:15	.030	−.5	10	St	S-1.0	4	NL	−1.0
Oct. 19	05:45	.011	−6.0	10	St	N-1.0	13	OG	−14.9
	06:20	.011	−5.8	10	St	N-1.0	13	OG	−14.9
Oct. 29	03:10	.102	−8.0	10	St. Cu	SW-2.2	3	NL	−7.8
Oct. 30	06:15	.036	−10.2	6 3	A. St St	NW-1.0	3	OL	−8.5
	07:15	.038	−10.4	5 3	A. St St	NW-1.0	3	OL	−8.7
Oct. 31	06:30	.042	−6.4	10	St	E-1.0	5	NL	−5.0
	07:30	.011	−5.8	9	St	E-1.0	5	NL	−5.0
Nov. 1	06:30	.011	−4.9	10	St	NW-1.0	5	NL	−4.0
Nov. 4	07:00	.031	−7.5	9	A. St	W-1.0	5	NL	−7.0
	08:00	.028	−8.0	7	A. St	W-1.0	5	NL	−8.6
Nov. 11	06:05	.011	−14.5	9	St	NW-1.0	28	NL	−13.2
	07:15	.011	−14.6	9	St	NW-1.0	28	NL	−14.2
Nov. 12	06:15	.011	−18.6	10	St	SE-1.0	28	OL	−17.5
	08:00	.011	−18.6	10	St	E-1.0	28	OL	−18.6
Nov. 18	07:45	.005	−24.6	10	St	E-1.0	29	NL	−23.4
Dec. 22	09:30	.020	−41.7		≡	C	41	OL	−44.4
	10:15	.021	−41.1		≡	E-1.0	41	OL	−43.5
Dec. 26	08:45	.011	−21.7	4 5	A. St St	C	42	NL	−22.4
	09:00	.011	−21.7	4 5	A. St St	C	42	NL	−22.4
	23:15	.017	−18.1	10	A. St	E-2.7	42	NL	−22.2
Dec. 27	08:30	.000	−11.2	10	St	C	43	NL	−11.8
	09:00	.000	−11.1	10	St	C	43	NL	−11.3
Dec. 30	07:00	.010	−3.0	10	St	C	61	OL	−4.7
	07:50	.005	−2.5	10	St	C	61	OL	−4.5
Dec. 31	09:00	.006	−2.2	9	St	E-1.8	64	NL	−4.2
	00:45	.006	0	9	St	S-4.0	64	NL	−3.5
	22:00	.003	−.8	10	St	E-3.6	64	NL	−4.8
	23:00	.003	−.8	10	St	E-2.2	64	NL	−4.5
1937									
Jan. 1	08:00	.038	1.1	6 3	Ci. St St	NE-3.6	64	NL	−4.0
	08:30	.038	1.3	6 2	Ci. St St	NE-3.6	64	NL	−4.2
Jan. 4	15:00	.042	−19.0	10	A. St., S	N-1.8	64	NL	−23.3
	15:30	.042	−18.8	10	A. St., S	N-1.0	64	NL	−23.2
	23:30	.007	−17.0	8	A. St., S	C	64	NL	−18.0
Jan. 5	01:30	.008	−17.0	8	A. St., S	C	52	NL	−17.8
	03:30	.002	−15.2	10	A. St., S	E-1.0	52	NL	−15.8
	07:30	.000	−14.8	10	A. St	SE-1.0	52	NL	−15.3
	09:30	.001	−14.8	10	A. St	NE-1.0	52	NL	−15.2
Jan. 6	23:30	.066	−1.0	10	A. St	NE-5.4	51	OD	−5.2
	24:00	.065	−1.0	10	A. St	NE-6.7	51	OD	−5.1

TABLE 4.—*Outgoing radiation, Fairbanks, Alaska*—Continued

PART III.—7/10-10/10 CLOUDINESS—Continued

Date	Local time	Q.	t.	Cloudiness: Amount	Cloudiness: Kind	Wind, direction—velocity (m. p. s.)	Snow surface: Depth (cm.)	Snow surface: Character of top layer	Snow surface: Temperature
1937		*Gm. ca./cm.²/mm.*							*°C.*
Jan. 7	09:00	0.009	0	10	St.	NE-1.8	51	OD	−2.3
	10:00	.012	.1	10	St.	N-1.8	51	OD	−2.3
Jan. 8	10:00	.009	−16.0	10	St.	N-1.0	53	NL	−16.5
	15:00	.049	−14.5	8	St.	N-1.0	53	NL	−16.8
	16:00	.009	−10.5	10	St.	N-1.0	53	NL	−12.0
Jan. 12	15:30	.120	−20.8	2 5	Ci. St. St.	S-1.0	51	OC	−28.0
Jan. 13	00:30	.013	−14.0	10	St.	N-1.8	51	OC	−15.5
Jan. 15	15:30	.048	−4.0	8	St.	SE-1.8	71	NL	−6.0
Jan. 17	01:00	.012	−11.2	9	St.	N-1.0	56	OD	−12.8
Jan. 18	08:30	.006	−15.5	10	St.	NE-1.0	56	OD	−16.4
Jan. 19	08:30	.046	−13.2	6 4	A. St. St.	NE-1.0	91	NL	−14.0
	09:00	.046	−13.2	7 3	A. St. St.	NE-1.0	91	NL	−14.2
	10:00	.021	−13.1	8 2	A. St. St.	NW-1.0	91	NL	−16.0
Jan. 21	14:30	.036	−1.4	10	St.	E-1.0	107	OC	−2.4
Jan. 22	09:00	.007	−15.0	−8	St.	W-7.2	109	NC	−16.0
Jan. 23	03:30	.054	−20.0	9	A. St.	NE-5.4	109	NC	−21.8
	07:30	.004	−11.2	10	St.	NE-4.5	109	NC	−14.6
	08:30	.004	−11.0	10	St.	E-2.7	109	NC	−14.5
Jan. 25	23:00	.018	−28.3	7	A. St.	N-1.0	107	OD	−31.0
	24:00	.003	−27.6	10	A. St.	C	107	OD	−28.6
Jan. 26	07.30	.028	−26.0	4 6	A. St. St.	C	107	OD	−25.5
	08:00	.003	−24.0	4 6	A. St. St.	C	107	OD	−23.5
Jan. 27	08:30	.048	−19.3	4 4	Ci. St. A. St.	NW-1.0	108	NL	−24.6
Jan. 29	16:30	.026	−5.3	8	St.	SW-5.4	117	NL	−7.0
Jan. 30	07:30	.011	−21.8	8	St.	N-1.0	117	NL	−22.0
	08:00	.001	−18.5	8	St.	NE-1.0	117	NL	−18.9
Feb. 8	07:45	.080	−16.0	4 4	A. St. St.	NE-1.0	127	NL	−21.8
	08:15	.052	−15.5	4 5	A. St. St.	NE-1.0	127	NL	−21.5
	08:45	.011	−17.5	3 7	A. St. St.	N-1.0	127	NL	−21.0
Feb. 9	07:15	.011	−20.7	10	St.	C	127	NL	−21.2
Feb. 10	15:15	.032	−28.6	7	St.	S-1.0	128	NL	−31.0
	15:30	.033	−28.4	7	St.	C	128	NL	−33.2
	16:00	.030	−27.9	7	St.	SE-1.0	128	NL	−32.5
Feb. 14	07:00	.022	−26.5	9	A. St.	NW-1.0	130	OL	−28.7
	07:20	.017	−26.8	9	A. St.	NW-1.0	130	OL	−29.8
	07:40	.026	−26.7	9	A. St.	NW-1.0	130	OL	−30.0
	08:00	.023	−26.8	9	A. St.	C	130	OL	−30.2
	08:20	.034	−28.0	9	A. St.	E-1.0	130	OL	−30.8
	15:00	.001	−17.4	2 8	A. St. St.	W-1.0	130	OL	−18.1
Feb. 15	07:45	.049	−25.5	5 4	A. St. St.	NE-1.0	131	NL	−30.2
	08:05	.069	−26.0	5 4	A. St. St.	NE-1.0	131	NL	−33.0
	15:40	.046	−26.2	8	A. St.	C	131	NL	−33.7
	16:10	.031	−26.0	9	A. St.	N-1.0	131	NL	−32.0
	16:40	.015	−26.0	9	A. St.	N-1.0	131	NL	−30.3
	17:10	.003	−26.7	9	A. St.	NW-1.0	131	NL	−27.0
Feb. 17	07.00	.009	−31.6	10	St., S.	C	131	NL	−32.5
	07:15	.009	−31.8	10	St., S.	C	131	NL	−32.3
	07:45	.019	−32.2	10	St.	NE-1.8	131	NL	−33.2
	08.15	.021	−33.0	6 3	A. St. St.	NW-1.0	131	NL	−34.8
	08:45	.028	−33.4	5 3	A. St. St.	NW-1.0	131	NL	−36.3
Feb. 18	06:00	.020	−42.2		≡	C	131	OL	−46.0
	06:30	.030	−44.4		≡	C	131	OL	−57.0
	07:00	.026	−45.1		≡	C	131	OL	−47.0
	07:30	.026	−45.1		≡	C	131	OL	−47.0
	08:00	.011	−42.7		≡	C	131	OL	−45.2
Feb. 19	06:30	.042	−35.0	8	A. St.	N-1.8	131	OL	−41.2
	07:00	.050	−35.0	8	A. St.	N-1.8	131	OL	−41.7
	07:30	.050	−33.8	8	A. St.	N-1.0	131	OL	−41.5
	08:00	.051	−32.0	8	A. St.	N-1.0	131	OL	−40.7
	16:30	.046	−18.0	9	A. St.	NW-1.0	131	OL	−24.0
	17:00	.044	−18.4	9	A. St.	NW-1.0	131	OL	−24.2
	17:30	.058	−18.9	9	A. St.	NW-1.0	131	OL	−26.5
Feb. 20	06:30	.046	−28.8	7	Ci. St.	NW-1.0	131	OL	−33.8
Feb. 22	06:15	.035	−25.0	10	St.	NW-1.0	131	OL	−28.2
	06:45	.038	−25.0	10	St.	NW-1.0	131	OL	−30.0
	07:15	.029	−25.1	10	St.	C	131	OL	−30.7
	07:45	.000	−25.3	10	St.	N-1.0	131	OL	−25.1
Feb. 24	06:45	.000	−20.0	9	St.	SW-1.0	132	NL	−19.5
	16:30	.000	−17.0	10	St.	SE-1.0	132	NL	−15.8
Feb. 25	16.30	.017	−14.0	6 3	A. St. St.	NW-1.0	133	NL	−14.0
	16.45	.017	−14.1	6 3	A. St. St.	NW-1.0	133	NL	−14.2
	17:00	.022	−14.3	7 2	A. St. St.	NW-1.0	133	NL	−14.6
	17;30	.023	−14.7	7 2	A. St. St.	W-1.0	133	NL	−15.1
	18:00	.037	−15.4	7 1	A. St. St.	C	133	NL	−16.0
Feb. 26	06:30	.009	−18.0	9	St.	E-1.0	133	NL	−18.8
	07:00	.016	−18.1	9	St.	E-1.0	133	NL	−18.9
	07:30	.008	−18.0	3 6	A. St. St.	C	133	NL	−19.0

TABLE 4.—*Outgoing radiation, Fairbanks, Alaska*—Continued

PART III.—7/10-10/10 CLOUDINESS—Continued

Date	Local time	Q.	t.	Cloudiness: Amount	Cloudiness: Kind	Wind, direction—velocity (m. p. s.)	Snow surface: Depth (cm.)	Snow surface: Character of top layer	Snow surface: Temperature
1937		*Gm./ca./cm.²/mm.*							*°C.*
Feb. 28	06:15	0.036	−22.2	9	St.	NW-1.0	135	NL	−23.7
	06:30	.035	−22.3	9	St.	N-1.0	135	NL	−24.8
	07:00	.041	−22.5	9	St.	C	135	NL	−27.3
	07:30	.020	−23.0	9	St.	N-1.0	135	NL	−27.7
	17:00	.055	−15.1	2 8	A. St. St.	W-1.0	135	NL	−20.4
	17.20	.054	−15.2	2 8	A. St. St.	W-1.0	135	NL	−20.6
	17:40	.050	−16.0	3 5	A. St. St.	NW-1.0	135	NL	−21.0
	18:20	.039	−17.4	5 3	A. St. St.	N-1.0	135	NL	−20.6
Mar. 1	06:30	.003	−18.8	10	St.	N-1.0	135	OL	−18.9
	06:45	.003	−18.8	10	St.	N-1.0	135	OL	−19.0
Mar. 4	06:00	.055	−32.5	7	St.	NW-1.0	135	OL	−38.8
	06:30	.035	−31.7	8	St.	NW-1.0	135	OL	−38.2
	07:00	.020	−30.6	8	St.	N-1.0	135	OL	−37.0
	07:30	.008	−32.3	8	St.	N-1.0	135	OL	−35.0
	16:45	.030	−20.5	9	St.	NW-1.0	135	OL	−25.5
	17:05	.065	−21.4	9	St.	NW-1.0	135	OL	−26.0
	17:25	.047	−21.0	9	St.	W-1.3	135	OL	−25.9
	17:45	.066	−22.2	9	St.	W-1.0	135	OL	−27.0
Mar. 5	05:45	.009	−22.0	9	St.	N-1.3	135	OL	−23.0
	06:15	.009	−22.0	9	St.	N-1.0	135	OL	−23.5
	06:45	.002	−22.0	9	St.	S-1.0	135	OL	−23.4
	16:30	.003	−19.4	9	St.	S-5.4	135	OL	−18.8
Mar. 6	16:45	.007	−19.5	9	St.	S-1.0	135	OL	−21.0
	17:15	.045	−20.0	9	St.	NW-1.0	135	OL	−22.2
	17:45	.028	−20.5	9	St.	NW-1.0	135	OL	−22.2
	18:15	.046	−20.2	8	St.	W-1.0	135	OL	−23.7
Mar. 7	05:45	.026	−23.5	9	St.	S-1.0	135	OL	−23.0
	06:15	.022	−23.7	9	St.	S-1.0	135	OL	−23.1
	06:45	.005	−24.0	9	St.	S-1.0	135	OL	−24.1
	07:15	.004	−24.0	9	St.	NW-1.0	135	OL	−24.4
Mar. 8	16:45	.016	−17.9	9	St.	SW-1.0	135	OL	−18.6
	17:00	.016	−18.0	9	St.	SW-1.0	135	OL	−18.9
	17:20	.016	−18.3	9	St.	SW-1.0	135	OL	−19.0
	17:40	.014	−18.7	9	St.	SW-1.0	135	OL	−19.0
	18:00	.011	−18.9	9	St.	SW-1.0	135	OL	−19.0
Mar. 9	18:30	.044	−19.4	5 2	A. St. St.	N-1.0	136	NL	−24.0
Mar. 10	17:15	.080	−8.0	7	A. St.	W-1.0	136	ND	−16.0
	17:30	.080	−8.2	7	A. St.	N-1.0	136	ND	−17.0
	18:00	.044	−8.5	8	S. St.	N-1.3	136	ND	−17.3
Mar. 11	05:30	.046	−15.9	8	A. St.	SE-1.8	136	OD	−18.6
	06:00	.025	−15.6	8	A. St.	E-1.3	136	OD	−18.9
	06:30	.019	−15.4	7	A. St.	NE-1.0	136	OD	−19.0
	17:30	.060	−10.0	8 2	A. St. St.	SE-1.0	136	OD	−17.1
	18:00	.044	−10.4	8 1	A. St. St.	SE-1.0	136	OD	−17.3
Mar. 14	18:00	.063	2.0	2 5	A. St. St.	NE-2.7	133	OD	−5.0
Mar. 15	05:30	.073	−8.1	8	Ci. St.	N-1.0	133	OD	−15.8
	06:00	.084	−8.0	8	Ci. St.	N-1.0	133	OD	−10.0
	06:30	.072	−8.0	8	Ci. St.	W-1.3	133	OD	−14.5
	07:00	.013	−9.8	8	Ci. St.	SW-1.0	133	OD	−14.0
	16:45	.101	3.9	8	A. St.	N-1.8	132	OD	−7.0
	17:00	.106	3.7	8	A. St.	N-1.8	132	OD	−7.2
	17:15	.100	3.2	7	A. St.	N-1.3	132	OD	−7.6
	17:45	.104	2.8	7	A. St.	N-2.2	132	OD	−8.2
Oct. 20	00:30	.074	−5.5	8	A. Cu.	Calm	1	OL	−5.9
Oct. 24	06:00	.056	−5.0	8	St. Cu.	NE-1.0	1	OG	−8.7
Oct. 25	01:15	.009	−3.6	10	St.	Calm	1	OG	−5.0
	06:15	.006	−2.3	10	St. Cu.	Calm	1	OG	−4.0
Oct. 28	06:15	.058	−10.7	8	A. Cu.	Calm	1	OG	−14.0
Oct. 29	06:00	.038	−14.7	8	A. Cu.	NW-1.0	1	OG	−16.5
Oct. 31	06:15	.046	−12.7	8	A. Cu.	NW-1.0	T	[1]	−15.8
Nov. 1	23:30	.022	−4.5	10	St.	Calm	T	[1]	−7.8
Nov. 2	06:15	.019	1.0	10	St.	N-1.0	T	[1]	−4.6
Nov. 3	06:15	.030	−5.3	8	St. Cu.	NW-1.0	T	[1]	−9.5
Nov. 4	06:10	−.004	−2.7	10	St.	NW-1.0			−4.6
Nov. 6	06:15	.025	−11.4	10	St. Cu.	W-1.0	9	NL	−13.8
Nov. 7	06:05	.002	−11.0	10	St.	Calm	9	OL	−11.0
Nov. 9	21:30	.011	−4.2	10	St.	N-1.0	10	OL	−6.0
Nov. 11	19:30	.009	−3.7	10	St.	N-1.0	10	OL	−5.4
	20:00	.018	−4.0	8	St.	N-1.0	10	OL	−5.8
	22:00	.042	−5.3	9	A. Cu.	Calm	10	OL	−8.0
Nov. 15	23:45	.003	−8.7	10	St.	NW-1.0	10	OL	−9.3
Nov. 27	06:45	.001	−12.3	9	St.	SW-1.8	10	OL	−14.3
Dec. 18	23:30	.087	.3	7	A. St.	E-1.0	18	OL	−8.9
	23:45	.084	−.1	7	A. St.	E-1.0	18	OL	−9.0
Dec. 20	22:15	.018	−15.2	10	St. Cu.	SE-1.0	20	NL	−17.0
	23:00	.017	−15.5	10	St. Cu.	SE-1.0	20	NL	−15.7
Dec. 21	23:30	.017	−3.5	10	St.	SW-4.5	23	NL	−5.7
	23:45	.017	−3.3	10	St.	SW-4.5	23	NL	−5.7
Dec. 23	07:00	.003	−10.0	10	St.	Calm	23	OC	−10.8
1938									
Jan. 3	23:30	−.038	−25.8	10	A. St.	NE-1.0	25	OL	−22.3
	23:50	−.041	−25.5	10	A. St.	E-1.0	25	OL	−22.1
Jan. 15	22:30	.009	−17.5	10	A. St.	N-1.0	20	OD	−19.0
	23:00	.009	−18.0	10	A. St.	Calm	20	OD	−19.8
Jan. 17	23:45	−.016	−20.0	10	St. Cu.	N-1.0	20	OD	−19.5
Jan. 22	00:30	.002	−26.6	10	A. St.	N-1.0	28	NL	−26.2
Jan. 29	22:00	.003	−30.2	8+		N-1.0	28	OL	−30.4
Feb. 1	22:00	.003	−24.2	10	A. St.	NW-1.0	34	NL	−22.6
	22:45	.003	−24.4	10	A. St.	Calm	34	NL	−22.8
Mar. 11	20:00	.052	−9.4	9	A. St.	N-18.	41	NL	−13.8

[1] Snow patches.

TABLE 5.—*Outgoing radiation, Fargo, N. Dak.*

PART I.—0-2/10 CLOUDINESS

Date	Local time	Q.	t.	Cloudiness		Wind, direction—velocity (m. p. s.)	Snow surface		
				Amount	Kind		Depth (cm.)	Character of top layer	Temperature
1936		*Gm. cal./cm.²/mm.*							*°C.*
Sept. 16	01:55	0.072	3.9	0		WNW-5.4	None		
	02:20	.087	3.6	0		WNW-5.4	None		
	02:55	.073	3.3	0		W-4.9	None		
Sept. 18	01:00	.082	6.1	0		E-1.8	None		
	01:28	.073	3.9	0		E-2.2	None		
	02:10	.071	3.2	0		ESE-2.7	None		
	03:00	.076	2.2	0		ESE-2.2	None		
	03:50	.082	1.4	0		ESE-1.8	None		
	23:25	.101	12.7	1	Cu. Nb.	N-2.7	None		
Sept. 19	00:05	.089	10.3	1	Cu. Nb.	N-2.2	None		
	00:35	.089	9.2	1	Cu. Nb.	N-2.2	None		
Dec. 31	19:30	.061	−18.2	0		WNW-3.1	5	NL	−20.0
	20:30	.061	−18.5	0		NW-4.0	5	NL	−20.0
	21:30	.071	−18.8	0		N-2.7	5	NL	−20.5
	22:30	.071	−20.0	0 =		NE-4.5	5	NL	−21.3
	23:30	.082	−22.0	0 =		N-1.8	5	NL	−23.2
1937									
Jan. 6	20:30	.036	−32.0	1	Ci	= NNW-7.6	24	NL	−33.0
	21:30	.036	−32.0	Few	Ci	= NW-3.1	24	NL	−34.0
	22:30	.028	−33.0	0		NW-5.4	24	NL	−34.0
	23:30	.052	−33.0	0		NW-4.9	24	NL	−35.0
Jan. 7	00:30	.025	−34.0	0		NW-4.0	24	NL	−35.0
	01:30	.022	−32.0	0		NW-6.3	24	NL	−33.0
	02:00	.036	−33.0	0		NNW-5.8	24	NL	−34.0
	19:30	.039	−29.0	1	A. st.	NNW-7.2	25	ND	−30.0
	20:30	.039	−29.0	0		N-6.7	25	ND	−31.0
	21:30	.025	−30.0	2	A. Cu.	N-7.2	25	ND	−32.0
Jan. 9	02:50	.036	−26.0	0		SSE-6.7	25	NL	−28.0
	03:00	.036	−26.0	0		SSE-6.7	25	NL	−28.0
	03:50	.039	−26.0	0		S-5.4	25	NL	−29.0
	04:25	.043	−26.0	0		S-4.5	25	NL	−29.0
	20:00	.056	−24.0	0		S-5.8	25	ND	−29.0
	21:00	.056	−25.0	0		S-6.7	25	ND	−31.0
	22:00	.056	−25.0	0		S-4.0	25	ND	−31.0
	24:00	.052	−25.0	0		S-5.4	25	ND	−29.0
Jan. 10	02:00	.052	−26.0	0		S-4.5	25	ND	−30.0
	02:40	.052	−28.0	0		S-4.9	25	ND	−31.0
	03:20	.052	−27.0	0		S-4.5	25	ND	−31.0
	04:00	.039	−26.0	0		S-4.5	25	ND	−31.0
Jan. 11	00:30	.043	−19.4	0		S-7.6	23	OC	−20.6
Jan. 12	22:30	.036	−15.6	2	Ci St.	SE-5.8	23	OC	−18.3
Jan. 14	21:00	.061	−28.3	0		N-4.5	28	OD	−28.9
	22:00	.056	−28.7	0		N-3.1	28	OD	−29.5
	23:00	.066	−30.4	0		N-3.1	28	OD	−30.6
	24:00	.061	−30.7	0		N-3.6	28	OD	−30.8
Jan. 15	03:00	.039	−31.7	0		Calm	28	OD	−32.2
	03:45	.047	−31.9	0		Calm	28	OD	−32.9
	21:15	.036	−26.0	Few	A. St.	E-2.2	28	OD	−29.6
	22:00	.039	−24.7	2	A. St.	SE-3.6	28	OD	−27.7
Jan. 17	19:20	.071	−25.2	0		SW-3.6	25	OD	−26.2
	22:40	.071	−28.2	1	Ci. St.	NW-3.6	25	OD	−29.0
	24:00	.056	−27.0	0		NW-3.1	25	OD	−27.5
Jan. 18	02:30	.066	−29.8	0		NW-1.8	25	OD	−30.0
	03:15	.056	−30.0	0		NW-3.1	25	OD	−30.0
	03:55	.056	−29.6	0		NW-3.1	25	OD	−30.0
Jan. 19	01:45	.066	−32.3	0		Calm	25	OD	−37.2
	02:10	.061	−32.8	0		Calm	25	OD	−37.7
	03:00	.061	−33.4	0		Calm	25	OD	−37.8
Jan. 22	02:10	.071	−33.9	Few	Ci	WSW-3.6	38	OD	−41.1
	02:35	.066	−34.1	Few	Ci	WSW-2.7	38	OD	−41.2
	03:05	.066	−34.4	Few	Ci	WSW-3.6	38	OD	−41.5
Jan. 22	03:35	.066	−35.1	0		SW-2.7	38	OD	−41.8
	03:45	.066	−35.2	0		SW-2.7	38	OD	−42.0
Feb. 1	20:00	.032	−25.6	0		SE-5.4	22	OD	−28.5
	24:00	.014	−23.9	0		SE-6.3	22	OD	−26.9
Feb. 4	20:00	.071	−24.8	0		NE-3.1	20	OD	−27.9
	21:00	.071	−24.4	0		E-2.2	20	OD	−27.0
Feb. 11	02:00	.076	−18.8	0		S-5.4	30	OC	−19.4
	03:00	.022	−18.8	0		S-4.5	30	OC	−19.4
Feb. 18	01:55	.042	−7.8	2	Ci. St.	S-3.6	30	OC	−10.8
	02:34	.065	−7.8	2	Ci. St.	S-5.4	30	OC	−9.2
Feb. 21	02:00	.082	−24.7	0		NW-3.6	15	OC	−25.0
	02:35	.082	−25.6	0		NW-4.5	15	OC	−25.0
	03:00	.067	−26.1	0		NW-3.6	15	OC	−25.6
Feb. 22	01:55	.068	−25.6	0		NW-7.6	15	OC	−24.6
	02:38	.078	−26.1	0		NW-7.2	15	OC	−25.0
	03:27	.069	−26.1	Few	A. St.	NW-8.0	15	OC	−25.0
Feb. 28	02:00	.061	−18.9	0		S-4.9	19	NL	−16.7
Mar. 14	02:00	.094	−16.2	0		NNW-2.7	8	NL	−18.0
	03:00	.090	−16.6	0		NNW-3.1	8	NL	−17.3
Oct. 4	02:00	.071	18.4	2	A. St.	SSE-9.8	None		18.8
	02:45	.072	18.2	2	A. St.	SSE-11.6	None		18.5
Oct. 5	01:45	.105	15.3	1	St. Cu.	S-4.5	None		16.4
	02:45	.089	12.9	0		WSW-4.5	None		14.1
Oct. 7	02:20	.106	3.9	0		NW-5.4	None		4.4
	03:30	.113	2.1	0		NW-5.4	None		2.7
Oct. 11	02:50	.052	2.9	0		WNW-3.6	None		3.3
	03:35	.047	2.2	0		W-1.8	None		2.7
Oct. 12	02:30	.100	−2.2	Few	St.	NNW-6.7	None		−2.1
	03:50	.094	−4.0	Few	St.	NW-3.6	None		−3.9
Oct. 13	02:00	.100	−7.7	0		NW-3.6	None		−7.1
	02:35	.109	−8.9	0		WNW-3.1	None		−7.2
Oct. 14	02:10	.094	−9.2	0		NW-1.8	None		−9.0
	03:15	.096	−9.8	0		N-1.8	None		−9.6
Oct. 15	02:00	.113	−3.3	Few	A. Cu.	SE-6.7	None		−3.2
	02:40	.109	−3.8	Few	A. Cu.	SE-6.3	None		−3.8
Oct. 16	02:00	.082	−.8	2	St. Cu.	ESE-4.9	None		−1.0
Oct. 23	02:19	.061	−4.7	2	A. Cu.	SE-5.4	None		−3.9

TABLE 5.—*Outgoing radiation, Fargo, N. Dak.*—Continued

PART I.—0-2/10 CLOUDINESS—*Continued*

Date	Local time	Q.	t.	Cloudiness		Wind, direction—velocity (m. p. s.)	Snow surface		
				Amount	Kind		Depth (cm.)	Ccharacter of top layer	Temperature
		Gm./cal./cm.²/mm.							*°C.*
1937									
Oct. 24	01:28	0.076	.1	0		N-3.1	None		0
	02:50	.074	−1.0	0		N-3.1	None		−1.1
Oct. 27	00:54	.088	−1.9	0		SW-1.0	None		−2.8
Oct. 28	01:31	.079	4.1	0		W-2.7	None		3.5
Oct. 29	01:46	.070	11.7	0		WSW-5.4	None		11.2
	03:16	.067	11.6	0		W-5.4	None		11.1
Oct. 30	01:15	.108	5.2	0		WNW-5.4	None		5.1
	02:24	.104	2.8	0		W-4.5	None		2.7
Nov. 1	01:37	.081	9.4	0		SSE-6.3	None		9.6
	02:40	.083	8.9	0		S-6.3	None		9.1
Nov. 3	02:00	.095	−13.3	0		SW-4.5	None		−13.2
	02:50	.076	−12.2	0		S-4.0	None		−12.2
Nov. 4	01:41	.097	−1.2	0		S-6.3	None		−1.2
	02:41	.047	−0.6	2	A. St.	SW-5.4	None		−.1
Nov. 6	01:33	.081	−1.8	0		SW-1.3	None		−1.9
	02:45	.084	−3.9	1	Ci.	SW-2.7	None		−2.6
Nov. 7	01:17	.064	2.9	0		N-5.4	None		3.4
	02:45	.060	2.1	0		N-3.6	None		2.2
Nov. 10	00:54	.101	.4	0		NNE-5.4	None		.7
	02:32	.088	−.2	0		N-3.6	None		−.3
Nov. 16	01:45	.100	−10.9	0		NNW-5.4	1	NL	−10.1
	02:50	.106	−11.1	0		N-4.9	1	NL	−10.0
Nov. 17	02:10	.085	−11.4	1	A. Cu.	NNW-5.8	1	NL	−10.9
	03:13	.102	−13.9	1	A. Cu.	NW-3.1	1	NL	−13.8
Nov. 24	22:30	.034	−1.8	Few	A. St.	SE-3.6	1	OL	−1.6
Nov. 27	01:46	.079	−11.9	0		WNW-8.5	1	OL	−9.7
	03:20	.058	−12.3	0		WNW-9.8	1	OL	−10.1
	21:07	.100	−16.6	0		W-5.4	1	OL	−15.1
	22:47	.090	−17.7	0		W.-4.5	1	OL	−16.3
Nov. 28	00:55	.091	−18.6	0		WNW-4.9	T	OD	−16.3
	01:55	.090	−18.6	0		WNW-4.9	T	OD	−17.8
	21:37	.095	−18.4	0		W-4.0	T	OD	−17.7
	23:10	.090	−18.2	0		W-4.0	T	OD	−17.8
Nov. 29	01:59	.079	−19.0	0		W-4.0	T	OD	−18.4
	22:15	.095	−17.7	0		W-3.6	T	OD	−16.8
	23:58	.085	−18.8	0		W-4.0	T	OD	−17.8
Nov. 30	01:08	.076	−20.6	0		SW-2.7	T	OD	−19.6
Dec. 2	02:00	.011	−7.4	0		SSE-8.9	T	OD	−8.3
	02:55	.012	−7.1	0		SE-8.9	T	OD	−7.9
	22:50	.011	−8.9	0		N-3.6	T	OD	−8.3
Dec. 5	20:50	.011	−23.9	0		N-2.2	T	OD	−23.2
Dec. 9	03:35	.083	−21.0	0		NW-8.5	8	NL	−20.6
	19:50	.083	−20.2	1	Ci. St.	NW-10.3	8	NL	−20.2
	20:48	.079	−21.1	0		NW-7.6	8	NL	−21.0
	21:45	.079	−21.2	Few	Ci.	NW-8.0	8	NL	−21.6
	22:45	.073	−21.4	0		NW-7.2	8	NL	−21.6
Dec. 10	00:54	.089	−21.1	0		WNW-6.3	8	NL	−21.3
	01:59	.068	−21.8	1	Ci. St.	WNW-4.9	8	NL	−23.2
	03:28	.071	−22.2	1	Ci. St.	NW-5.4	8	NL	−23.8
Dec. 13	01:54	.074	−12.7	2	St. cu.	E-3.1	5	OL	−14.8
	03:01	.070	−14.2	1	Ci. St.	E-2.7	5	OL	−10.4
Dec. 17	03:10	.070	−4.9	1	Ci. St.	SW-4.5	5	OL	−5.4
Dec. 27	20:50	.007	−15.6	Few	St.	NNW-7.6	13	OL	−14.9
	21:50	.007	−16.8	0		N-7.2	13	OL	−17.8
Dec. 28	03:45	.038	−20.7	1	St. Cu.	N-1.0	13	OC	−20.4
	22:20	.018	−11.9	2	St. Cu.	SE-7.2	13	OC	−13.1
	23:30	.042	−12.4	0		SE-5.4	13	OC	−13.7
Dec. 29	20:45	.059	−12.9	0		N-4.0	13	OC	−13.3
	21:45	.036	−14.1	0		N-4.5	13	OC	−14.3
	22:45	.049	−14.5	0		N-4.0	13	OC	−14.1
Dec. 30	00:31	.045	−15.6	0		N-3.1	13	OC	−15.6
	01:53	.036	−15.4	0		N-3.6	13	OC	−16.6
1938									
Jan. 3	00:44	.049	−11.1	2	A. St.	S-4.0	10	OC	−10.7
Jan. 4	00:45	.067	−7.1	0		W-4.5	10	OC	−7.7
	01.52	.080	−8.8	0		WSW-3.1	10	OC	−10.9
	23:00	.036	−15.4	2	St.	E-1.8	10	OC	−15.1
Jan. 5	03:18	.071	−17.2	0		NE-1.3	10	OC	−20.3
Jan. 13	21:50	.078	−13.2	0		N-6.3	10	OC	−14.2
	23:23	.074	−15.1	0		N-6.3	10	OC	−16.2
Jan. 14	01:15	.076	−18.4	0		N-6.3	10	OC	−20.7
	02:10	.080	−20.3	0		NW-2.7	10	OC	−22.2
Jan. 15	01:25	.049	−10.0	0		SE-10.7	10	OC	−11.0
	03:00	.047	−9.7	0		SSE-9.8	10	OC	−10.7
Jan. 16	00:44	.055	−5.3	2	Ci. St.	N-4.0	10	OC	−6.2
Jan. 22	19:45	.065	−6.1	0		S-4.9	13	OC	−10.6
	23:10	.113	−9.3	1	A. Cu.	SSE-6.3	13	OC	−7.7
Jan. 23	02:09	.059	−2.9	1	A. Cu.	SE-7.2	13	:OC	−5.6
	03:10	.068	−2.1	1	A. Cu.	SE-9.8	13	OC	−4.9
Jan. 24	01:56	.058	−9.1	2	St.	N-11.2	13	OC	−9.6
Jan. 25	23:39	.076	−23.3	0		NNW-4.9	13	OC	−24.9
Jan. 26	01:56	.075	−24.3	2	A. Cu.	NW-4.0	13	OC	−25.1
	03.40	.031	−23.8	1	A. Cu.	NW-3.6	13	OC	−25.4
	20.30	.100	−22.7	0		N-5.4	13	OC	−22.9
	22:10	.090	−24.8	0		N-4.5	13	OC	−25.3
Jan. 27	00:51	.089	−27.1	0		N-3.6	10	OC	−27.6
	01:52	.090	−27.2	0		N-4.0	10	OC	−28.1
	02:50	.090	−29.1	0		NW-2.7	10	OC	−29.8
Jan. 29	22:49	.071	−22.8	Few	Ci. St.	N-4.9	10	OC	−23.9
	23:41	.072	−23.8	0		N-5.4	10	:OC	−24.3
Jan. 30	00:46	.063	−23.4	0		NNW-6.7	10	OC	−23.9
	01:47	.062	−25.0	0		NNW-7.6	10	OC	−25.7
	03:12	.060	−26.3	0		NW-6.7	10	OC	−27.1
	19:54	.039	−24.7	2	St.	W-3.6	10	OC	−27.1
	22:42	.058	−27.2	0		W-4.9	10	OC	−28.5
Jan. 31	00:32	.068	−27.5	0		W-4.9	10	OC	−29.4
	02:01	.078	−28.0	0		W-5.8	10	OC	−29.3
	03:16	.069	−28.4	0		W-4.5	10	OC	−30.1
	19:43	.064	−24.9	0		S-3.1	10	OC	−28.9
	22:42	.094	−25.5	0		SE-3.6	10	OC	−28.4

TABLE 5.—*Outgoing radiation, Fargo, N. Dak.*—Continued

PART I.—0-2/10 CLOUDINESS—Continued

Date	Local time	Q.	t.	Cloudiness		Wind, direction—velocity (m. p. s.)	Snow surface		
				Amount	Kind		Depth (cm.)	Character of top layer	Temperature
		Gm. ca./cm.²/mm.							°C.
1938									
Feb. 4	00:37	0.051	−17.7	0		E-5.8	13	OC	−18.9
	01:49	.052	−12.0	0		ESE-5.8	13	OC	−14.2
	02:53	.052	−11.1	0		SE-6.7	13	OC	−13.3
	23:47	.083	−10.8	0		W-3.6	13	OC	−11.8
Feb. 5	00:35	.079	−12.1	0		SW-2.7	13	OC	−13.3
	01:18	.076	−12.4	0		S-4.0	13	OC	−13.6
Feb. 6	23:42	.089	−12.8	1	St.	SE-6.3	13	OC	−14.1
Feb. 7	00:55	.050	−12.2	1	St.	SE-6.7	13	OC	−13.6
Feb. 17	23:20	.088	−26.3	0		W-4.5	25	NL	−26.4
Feb. 18	21:30	.056	−22.8	0		S-1.8	25	OC	−25.5
	22:50	.070	−24.9	0		Calm	25	OC	−27.6
Feb. 19	21:00	.049	−20.4	1	Ci.	N-2.2	25	OC	−21.1
	22:44	.053	−21.3	0		N-1.3	25	OC	−21.4
Feb. 20	01:44	.056	−23.8	2	A. St.	N-2.7	23	OC	−24.0
	19:43	.046	−14.6	2	Ci. St.	SW-1.8	23	OC	−18.7
Feb. 26	20:39	.111	1.9	0		NW-7.6	15	OC	.1
	22:50	.105	1.7	0		NW-8.5	15	OC	−.9
Feb. 27	01:07	.053	−.2	0		NW-5.8	10	OC	−2.9
	03:08	.126	−1.5	0		NW-6.3	10	OC	−2.7
Mar. 5	22:07	.083	−12.4	0		NW-4.0	8	NL	−14.4
	23:33	.093	−13.3	0		NW-4.0	8	NL	−15.7
Mar. 6	21:47	.081	−6.2	2	Ci. St.	W-7.2	5	OC	−7.3
	22:44	.089	−5.8	2	Ci. St.	W-6.7	5	OC	−6.3
Mar. 7	01:46	.080	−9.6	Few	Ci. St.	SW-4.5	5	OC	−10.2
	03:20	.075	−10.1	Few	Ci. St.	WSW-5.4	5	OC	−10.6
	23:55	.101	−4.6	1	St. Cu.	S-2.2	5	OC	−5.4
Mar. 8	01:45	.102	−9.1	Few	St. Cu.	NE-2.2	3	OC	−11.3
	03:20	.102	−11.2	Few	A. St.	WNW-2.2	3	OC	−11.2
Mar. 11	02:41	.079	−1.4	0		WSW-4.5	T	OC	−2.9
	20:35	.069	2.9	Few	Ci.	SW-7.2	T	OC	.6

PART II.—3/10-6/10 CLOUDINESS

Date	Local time	Q.	t.	Amount	Kind	Wind	Depth (cm.)	Character of top layer	Temperature
1936									
Dec. 27	18:15	0.070	−18.9	6	Ci. St.	NNW-3.6	1	OD	−18.9
1937									
Jan. 1	00:30	.076	−22.3	3	Ci. St.	N-2.2	5	NL	−22.5
	01:30	.066	−22.7	3	Ci. St.	NE-1.3	5	NL	−23.3
Jan. 7	04:00	.004	−32.0	5	A. St.	NW-6.7	24	NL	−32.0
	04:20	.005	−32.0	4	A. St.	NW-6.7	24	NL	−32.0
	05:00	.019	−32.0	6	A. St.	NW-4.5	24	NL	−33.0
	22:00	−.014	−30.0	2	A. Cu.	N-7.2	25	ND	−32.0
	22:30	.006	−29.0	3	A. Cu.	N-8.9	25	ND	−29.0
Jan. 11	01:30	.016	−19.6	4	A. St.	S-4.9	23	OC	−20.8
Jan. 12	20:30	.052	−14.4	3	Ci. St.	E-3.1	23	OC	−18.9
Oct. 23	04:12	.060	−4.0	4	A. Cu.	SSE-6.3	None		−3.4
Oct. 25	01:12	.068	7.9	4	A. Cu.	SW-5.4	None		7.7
Oct. 26	03:30	.038	2.3	3	A. Cu.	SW-5.4	None		1.4
Oct. 28	03:26	.047	2.8	2 3	Ci. St. A. Cu.	W-1.3	None		2.3
Nov. 9	02:53	.041	.6	6	A. St.	SSE-8.0	None		1.0
	04:00	.045	.8	4	A. St.	SSE-8.0	None		1.2
Dec. 13	00:59	.069	−10.2	4	St. Cu.	E-2.7	5	OL	−12.4
Dec. 17	01:54	.080	−3.5	4	Ci. St.	SW-4.5	5	OL	−4.6
Dec. 29	00:58	.030	−12.8	3	St. Cu.	SE-4.5	5	OC	−13.9
	02:21	.030	−12.5	3	St. Cu.	SE-4.5	5	OC	−14.1
1938									
Jan. 2	20:50	.016	−12.2	6	A. St.	SSE-7.2	10	OC	−12.1
Jan. 4	22:55	−.004	−15.4	6	St.	E-1.8	10	OC	−15.1
Jan. 5	00:46	.020	−16.0	3	St.	N-2.2	10	OC	−16.4
Jan. 14	21:53	.047	−11.3	4	Ci.	SSE-11.2	10	OC	−12.2
Jan. 27	22:43	.015	−17.1	5	A. St.	SE-11.6	10	OC	−17.1
Feb. 1	01:55	.034	−23.3	3	A. St.	SE-4.0	10	OC	−23.0
	19:45	.044	−12.6	6	A. St.	ESE-6.7	10	OC	−13.5
Feb. 3	21:39	.016	−17.1	6	Ci. St.	E-3.6	13	NL	−18.2
	22:55	.013	−15.4	3	Ci. St.	E-3.6	13	NL	−16.7
Feb. 6	20:46	.072	−12.7	4	St.	SE-3.1	13	OC	−14.9
	22:41	.075	−12.3	5	St.	SSE-3.6	13	OC	−14.5
Feb. 19	19:52	.025	−18.6	3	Ci.	NE-1.8	25	OC	−19.2
Feb. 27	19:49	.115	−3.8	3	St.	N-3.6	10	OC	−4.1
Mar. 8	20:50	.069	−4.3	4	St. Cu.	S-4.5	3	OC	−4.9
	22:44	.067	−5.1	4	St. Cu.	S-4.0	3	OC	−5.6
Mar. 10	22:05	.059	−.9	3	Ci. St.	W-5.8	3	OC	−2.7
Mar. 11	01:29	.068	−1.2	6	Ci. St.	SW-4.5	T	OC	−2.6
	22:40	.076	2.6	4	Ci. St.	W-5.8	T	OC	−0.5
Mar. 12	02:24	.088	2.3	5	Ci. St.	W-5.8	T	OC	−0.5

PART III.—7/10-10/10 CLOUDINESS

Date	Local time	Q.	t.	Amount	Kind	Wind	Depth (cm.)	Character of top layer	Temperature
1936									
Dec. 27	20:15	0.022	−19.0	9	Ci. St.	N-4.5	1	OD	−19.0
	21:20	.028	−19.0	8	Ci St.	N-5.4	1	OD	−19.0
	22:20	.045	−18.0	8	Ci. St.	N-5.4	1	OD	−19.0
	23:30	.004	−17.2	3 7	Ci. St. A. Cu.	N-5.4	1	OD	−19.0
1937									
Jan. 1	02:30	.028	−22.2	8	Ci. St.	NNE-1.3	5	NL	−23.0
Jan. 7	03:00	.002	−32.0	8	A. St.	NW-4.5	24	NL	−32.0
	03:30	.002	−32.0	9	A. St.	NW-4.0	24	NL	−32.0
Jan. 8	01:45	.000	−28.0	10	A. St.	N-7.6	25	ND	−28.0
	02:45	.002	−28.0	7	A. St.	N-6.7	25	ND	−29.0
	03:30	.002	−27.0	7	A. St.	N-7.2	25	ND	−28.0
	04:00	−.005	−27.0	10	A. St.	N-8.0	25	ND	−27.0
	04:30	.005	−27.0	10	A. St.	N-7.2	25	ND	−27.0

TABLE 5.—*Outgoing radiation, Fargo, N. Dak.*—Continued

PART III.—7/10-10/10 CLOUDINESS—Continued

Date	Local time	Q.	t.	Cloudiness: Amount	Cloudiness: Kind	Wind, direction—velocity (m. p. s.)	Snow surface: Depth (cm.)	Snow surface: Character of top layer	Snow surface: Temperature
		Gm./ca./cm.²/mm.							°C.
1937									
Jan. 11	02:30	0.016	−19.3	7	A. St.	S-6.3	23	OC	−20.5
	03:15	−.004	−18.3	10	A. St.	S-4.5	23	OC	−18.9
Jan. 15	23:00	.004	−23.1	10	A. St.	SE-5.8	28	OD	−23.3
Jan. 23	01:30	.022	−26.7	7	Ci. St.	SE-7.2	38	OD	−28.4
	03:45	−.014	−24.4	10	St. Cu.	SE-6.3	38	OD	−23.9
Jan. 26	01:30	.047	−29.0	8	Ci. St.	S-2.2	25	OD	−31.1
	02:30	.002	−26.7	10	A. Cu.	SE-4.5	25	OD	−27.8
	03:30	.000	−26.1	10	A. Cu.	SE-5.4	25	OD	−26.7
Jan. 28	21:00	.014	−23.4	9	Ci. St.	NNE-5.4	22	NL	−22.9
	22:00	.006	−23.2	10	Ci. St.	N-3.1	22	NL	−22.9
	23:00	.005	−23.1	10	Ci. St.	N-5.4	22	NL	−22.2
	24:00	.022	−23.4	10	Ci. St.	N-4.5	22	NL	−22.8
Jan. 29	01:00	.002	−22.8	10	Ci. St.	N-4.9	22	NL	−22.5
	02:00	.000	−22.3	10	Ci. St.	N-4.0	22	NL	−21.8
	03:00	.000	−23.1	10	Ci. St.	N-4.5	22	NL	−22.6
Feb. 4	22:00	.010	−23.8	10	A. St.	E-1.0	20	OD	−26.1
Feb. 5	02:30	.004	−21.1	10	A. St.	SSE-3.1	20	OD	−21.1
	03:10	.002	−21.0	10	A. St.	SSE-4.5	20	OD	−21.0
Feb. 19	01:58	.017	−10.1	7	Ci. St.	S-3.6	21	NL	−11.0
	02:46	.039	−9.4	7	Ci. St.	SSE-2.7	21	NL	−11.4
	03:16	.036	−9.3	7	Ci. St.	S-4.0	21	NL	−10.3
Oct. 1	03:35	.015	6.3	10	St. Cu.	NNE-5.4	None		6.7
Oct. 2	01:55	.006	8.0	10	St.	ESE-6.7	None		8.5
	02:45	.005	8.1	10	St.	ESE-6.7	None		8.4
Oct. 8	02:25	.006	4.1	10	A St.	SE-6.3	None		4.4
Oct. 16	02:50	.054	−1.7	9	St. Cu.	ESE-4.5	None		−1.8
Oct. 19	02:00	.026	5.6	10	St. Cu.	WNW-7.6	None		5.7
	03:00	.022	5.5	10	St. Cu.	NW-8.9	None		5.6
Oct. 20	02:30	.019	4.4	10	St. Cu.	NW-6.3	None		4.5
	03:40	.016	4.8	10	St. Cu.	NW-5.8	None		4.7
Oct. 21	02:25	.025	2.4	10	St. Cu.	NNW-9.8	None		2.8
	03:35	.026	.7	10	St. Cu.	N-10.7	None		1.1
Oct. 22	02:30	.028	−2.6	10	St. Cu.	N-6.3	None		−2.7
	03:30	.028	−2.9	10	St. Cu.	N-7.2	None		−2.8
Oct. 25	02:14	.074	9.3	7	A. Cu.	NW-8.0	None		9.1
Oct. 26	02:25	.056	2.7	7	A. Cu.	SW-3.1	None		2.3
Oct. 31	01:24	.088	3.9	10	A. Cu.	E-2.2	None		4.0
	02:17	.093	3.9	10	A. Cu.	E-3.6	None		3.9
Nov. 2	02:02	.033	−3.9	10	St. Cu.	NW-15.6	None		−4.3
	02:45	.041	−4.4	10	St. Cu.	NW-13.4	None		−4.9
Nov. 5	00:53	.026	−.1	10	St. Cu.	N-8.0	None		0.1
	02:10	.023	−.5	10	St. Cu.	NNW-5.4	None		−0.4
Nov. 13	01:05	.024	7.2	10	St.	E-1.0	None		6.9
	02:40	.025	6.8	10	St.	N-3.6	None		7.0
Nov. 18	20:20	.021	−12.3	10	A. Cu.	WNW-5.4	1	NL	−11.5
	21:05	.032	−11.4	10	A. Cu.	NW-5.8	1	NL	−11.2
	22:20	.034	−11.6	10	A. Cu.	NW-5.4	1	NL	−11.7
	23:30	.031	−11.7	3 7	Ci. St. Cu.	NW-5.4	1	NL	−12.1
Nov. 25	00:05	.023	−1.1	10	A. St.	SE-2.7	1	OL	−1.6
Nov. 30	23:50	.069	−11.8	10	St. Cu.	N-2.7	T	OD	−8.8
Dec. 1	01:55	.015	−11.9	10	St. Cu.	NNW-2.7	T	OD	−10.5
	02:55	.014	−12.1	10	St. Cu.	NW-2.7	T	OD	−11.1
Dec. 11	20:05	.004	−9.6	8 2	A. St. St.	SE-8.9	8	OL	−9.7
	21:50	.004	−9.9	4 3	A. St. St.	SE-7.6	8	OL	−10.1
	22:45	.004	−10.2	10	St.	SE-7.2	8	OL	−10.2
	22:50	.004	−10.2	10	St.	SE-7.2	8	OL	−10.2
Dec. 12	01:54	.004	−10.1	10	St. Cu.	ESE-5.8	8	OL	−10.2
	23:50	.009	−7.4	9	St. Cu.	E-1.8	5	OL	−8.6
Dec. 16	21:50	.031	−2.2	10	Ci. St.	SSW-4.9	5	OL	−3.6
	22:50	.016	−1.6	10	Ci. St.	S-40	5	OL	−2.9
	23:40	.057	−1.9	7 2	Ci. St. A. Cu.	SSW-4.9	5	OL	−2.9
Dec. 17	01:01	.062	−2.7	7	Ci. St.	SSW-3.6	5	OL	−5.2
	19:15	.015	−3.8	10	St. Cu.	N-4.5	5	OL	−5.8
	20:45	.006	−5.4	10	St. Cu.	N-4.0	5	OL	−6.0
	21:50	.009	−5.9	10	St. Cu.	N-4.0	5	OL	−6.4
	22:55	.007	−7.1	10	St.	NE-4.9	5	OL	−7.2
Dec. 18	01:17	.007	−7.2	10	St. Cu.	E-2.7	5	OL	−7.2
	21:50	.004	−10.8	10	A. Cu.	N-5.8	5	OL	−12.1
	22:45	.004	−10.7	10	A. Cu.	NNE-4.9	5	OL	−12.2
Dec. 19	00:40	.004	−10.4	10	St. Cu.	N-5.8	8	NL	−12.4
	02:06	.005	−9.7	10	St. Cu.	NE-4.0	8	NL	−11.4
Dec. 21	03:04	.008	1.8	10	St. Cu.	W-7.2	8	NL	−.2
Dec. 26	02:01	.034	−25.9	7	St. Cu.	W-3.6	13	NL	−26.1
	03:45	.028	−23.1	10	St.	W-3.1	13	NL	−23.2
Dec. 28	02:45	.004	−20.8	8	St. Cu.	N-1.8	13	OL	−20.7
1938									
Jan. 2	19:50	.028	−12.3	10	A. St.	SSE-10.7	10	OC	−12.6
	21:45	.011	−11.8	10	A. St.	SSE-7.6	10	OC	−12.2
Jan. 3	21:43	.030	−6.7	10	A. St.	SE-5.4	10	OC	−8.5
	22:30	.024	−6.6	10	A. St.	W-4.5	10	OC	−7.7
Jan. 4	20:55	.005	−15.3	10	St.	E-2.7	10	OC	−15.3
	21:00	.004	−15.3	10	St.	E-2.7	10	OC	−15.3
	21:55	.004	−14.8	10	St.	NE-2.2	10	OC	−14.8
Jan. 5	02:09	.049	−16.3	10	St.	NE-1.8	10	OC	−16.9
Jan. 14	19:53	.038	−10.6	9	A. Cu.	SE—10.7	10	OC	−11.2
Jan. 15	20:47	.010	−4.1	10	A. St.	N-5.8	10	OC	−4.6
	22:40	.049	−4.0	8	Ci.	NE-6.7	10	OC	−4.6

TABLE 5.—*Outgoing radiation, Fargo, N. Dak.*—Continued

PART III.—7/10-10/10 CLOUDINESS—Continued

Date	Local time	Q.	t.	Cloudiness: Amount	Cloudiness: Kind	Wind, direction—velocity (m. p. s.)	Snow surface: Depth (cm.)	Snow surface: Character of top layer	Snow surface: Temperature
1938		Gm./cal./cm.²/mm.							°C.
Jan. 17	00:59	0.015	−6.3	10	St.	NW-8.5	13	NL	−6.7
	01:50	.016	−7.8	10	St.	NW-6.7	13	NL	−7.6
	02:53	.018	−8.9	10	St.	NW-7.6	13	NL	−8.6
Jan. 19	02:41	.017	−5.5	10	St.	S-6.7	13	OC	−6.2
	03:40	.016	−5.1	10	St.	S-5.4	13	OC	−5.7
	21:01	.004	−5.7	10	St.	NE-2.2	13	OC	−6.1
	22:48	.007	−6.2	10	St.	E-2.7	13	OC	−6.3
Jan. 30	00:32	.006	−6.3	10	St.	E-2.7	13	OC	−6.4
	01:52	.004	−6.6	10	St.	E-4.0	13	OC	−6.2
	02:59	.005	−6.7	10	St.	E-4.0	13	OC	−6.6
	03:37	.005	−6.9	10	St.	E-4.0	13	OC	−6.8
Jan. 23	00:59	.021	−3.1	7	A. Cu.	SE-7.6	13	OC	−4.5
	19:47	.021	−1.2	10	St.	N-8.0	13	OC	−1.8
	22:18	.032	−4.3	10	St.	N-11.2	13	OC	−4.5
Jan. 24	00:55	.034	−6.6	10	St.	N-14.3	13	OC	−5.8
	03:15	.014	−9.6	10	St.	N-11.6	13	OC	−9.5
Jan. 27	19:48	.015	−18.1	10	A. St.	SE-9.8	10	OC	−18.1
	20:43	.015	−17.4	10	A. St.	SSE-8.5	10	OC	−17.1
Jan. 28	00:32	.004	−15.4	10	A. St.	SE-13.4	10	OC	−15.6
	02:00	.004	−15.1	10	A. St.	SE-12.5	10	OC	−15.3
	03:44	.005	−13.2	10	A. St.	SSE-10.7	10	OC	−13.9
	19:50	.011		10	A. St.	N-6.3	10	OC	−14.4
	23:41	.011	−15.8	10	A. Cu.	N-4.5	10	OC	−16.1
Jan. 29	00:50	.009	−16.0	10	A. St.	NE-4.9	10	OC	−16.3
Feb. 1	02:51	.013	−22.3	7	A. St.	SE-5.4	10	OC	−22.6
	23:46	.074	−12.7	10	St.	ESE-8.5	10	OC	−15.4
Feb. 2	00:41	.021	−12.4	10	St.	E-6.7	10	OC	−14.8
	02:21	.004	−12.4	10	St.	E-8.9	10	OC	−14.3
	03:25	.008		10	St.	N-6.7	10	OC	−14.1
Feb. 8	21:17	.010	−13.9	10	St.	N-8.0	13	OC	−13.4
Feb. 9	01:45	.010	−16.5	10	St.	N-9.8	13	OC	−15.7
	21:40	.013	−20.2	8	A. St.	N-2.2	13	OC	−20.7
Feb. 15	19:42	.013	−23.7	8	Ci. St.	N-5.8	20	NL	−22.7
	20:50	.021	−22.8	10	A. Cu.	N-5.4	20	NL	−21.8
Feb. 16	02:00	.012	−20.4	10	A. St.	NNE-4.9	18	OC	−18.7
	03:16	.014	−19.7	10	St. Cu.	NNE-4.0	18	OC	−18.3
Mar. 7	20:53	.021	−3.8	9	St. Cu.	E-2.2	5	OC	−4.3
Mar. 10	20:15	.047	.4	9	A. Cu.	W-7.2	3	OC	−.9

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